Engineering Library

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLIII.—No. 3722] LONDON: FRIDAY EVENING, MAY 13, 1927 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

1. WELDLESS STEEL BUFFERS and PARTS.
2. ABOUT 2860 Tons of BRIDGEWORK

Tenders due on the 27th May, 1927, for No. 1, and on the 10th June, 1927, for No. 2.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 5466

Assistant Engineers Re- QUIRED for RAILWAY SURVEY by the GOVERNMENT of NIGERIA, for a tour of 12 to 18 months' service. Salary £720, rising to £920 a year by annual increments of £40. Commuted bush and detention allowance of £9 a month. Camp equipment provided. Free passages and liberal leave on full salary. Candidates, not over 45, must have passed Examination to qualify for A.M.I.C.E. Diploma or hold equivalent professional qualifications, and have had experience in Charge of Railway Location.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, mentioning this paper, and quoting M/15,138. 5465

Test Assistants, with technical training to the standard of B.Sc. Degree in Pure and Applied Mathematics, Science or Engineering, REQUIRED in connection with the airworthiness approval of aircraft.

Works and drawing-office training and experience in aerodynamic or structural strength calculations or in the use of higher mathematics an advantage.

Salary about 60s. plus Civil Service bonus per week, giving a present total remuneration of £4 17s. 3d.

Preference given, other things being equal, to ex-Service men.

Write, giving full particulars and quoting reference No. A. 174, to the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 5436

In the High Court of Justice 1926 H. 061
Chancery Division
Mr. Justice Tomlin
In the Matter of HEWITT and KELLETT Limited and Reduced and
In the Matter of the COMPANIES (CONSOLIDATION) ACT 1908

Notice is Hereby Given that the Order of the High Court of Justice Chancery Division dated the 12th day of April 1927 confirming the reduction of the capital of the above-named Company from £36,000 to £10,800 and the Minute approved by the Court showing with respect to the share capital of the Company as altered, the several particulars required by the above Act, were registered by the Registrar of Companies on the 2nd day of May 1927.

Dated this 6th day of May 1927.

JAMES B. SOMERVILLE,
11, New-square, Lincoln's Inn, London, W.C. 2,
Agent for F. G. and H. E. Smith, 33, Kirkgate, Bradford, Yorkshire, Solicitors for the said Company. 5431

Robert Gordon's Colleges, ABERDEEN.

The Governors invite APPLICATIONS for the POST of HEAD of the ELECTRICAL ENGINEERING DEPARTMENT.

Candidates must be University Graduates in Engineering and have had thorough practical training in Electrical Engineering and experience of instruction. Salary £500-£600 according to qualifications.

The Engineering Department of the College co-operates with the University of Aberdeen in providing Degree Courses in Engineering.

A statement of the duties attaching to the appointment may be had from the undersigned, with whom 17 copies of letter of application and of testimonials should be lodged not later than 31st May.

JAMES McKENZIE,
5442 Secretary and Registrar.

Administrative County of LONDON.
ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

The London County Council invites APPLICATIONS for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advanced study or research in applied science and technology, and will be tenable in the Dominions, the United States or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and applications forms (T.2.a/300) may be obtained from the Education Officer (T.2.a.), The County Hall, S.E. 1 (stamped addressed envelope necessary), to whom the form must be returned by 18th June, 1927.

MONTAGU H. COX,
5425 Clerk of the London County Council.

Government of Northern IRELAND.
NOTICE TO CONTRACTORS FOR BORING WORKS.

The Ministry of Finance invites separate TENDERS for the following :—

(1) The HIRE, at a fixed charge per week, of a 3in. ROTARY BORING PLANT suitable for hand power, complete with all necessary Equipment for Boring Test Holes 250ft. deep ;
(2) MAKING ROTARY BORINGS (3in. test holes) at specified points along the banks of the River Bann between Toome and Coleraine, the contractor to provide his own plant and labour and to produce cores for the full depth of each hole.

Forms of Tender and drawings showing the exact position and depth of each test hole can be obtained on application to the Ministry's Director of Works, 113, Royal-avenue, Belfast. Each Tender must be for a lump sum for the work indicated by the plans and must also state a unit cost per foot of depth for any extra boring that may be required.

The envelope containing the Tender is to be addressed to the Secretary, Ministry of Finance, 15, Donegall-square West, Belfast, and marked "Tender for Boring." Tenders will be received up to, but not later than, 3 p.m. on the 17th day of June, 1927. The Ministry is not bound to accept the lowest or any Tender. Preference will be given to firms on the King's National Roll.

R. E. THORNLEY,
Assistant Secretary.
Ministry of Finance, Belfast,
12th May, 1927. 5478

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

20,000 Kilowatt Turbo-Alternator (With a Two-Page Drawing). THE ENGINEER, 13-5-27.

The Modern Steam Engine and Internal Combustion Motors—No. V. (MAURICE DEMOULIN.) THE ENGINEER, 13-5-27.

The Iron and Steel Institute—No. I. THE ENGINEER, 13-5-27.

Royal Society's Conversazione. THE ENGINEER, 13-5-27.

Paint Making Machinery—No. V. THE ENGINEER, 13-5-27.

The James Forrest Lecture—No. II. (H. C. H. CARPENTER.) THE ENGINEER, 13-5-27.

Suction Gas for Commercial Vehicles—No. II. THE ENGINEER, 13-5-27.

Institute of Metals—The May Lecture. (SIR HENRY A. MIERS.) THE ENGINEER, 13-5-27.

An Airless Injection Oil Engine—No. I. THE ENGINEER, 13-5-27.

A Lifeboat Launching Tractor. THE ENGINEER, 13-5-27.

PUBLIC NOTICES

B. & C.I. Railway Company. The Directors are prepared to receive up to Noon on Wednesday, 25th May, TENDERS for the SUPPLY of—

SPRING STEEL.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each, which will not be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, S.W. 1.
9th May, 1927. 5462

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. LOCOMOTIVE TURNTABLES.
2. CAST IRON POT SLEEPERS.
3. ROLLED STEEL DISC WHEELS and AXLES.
4. TIE BARS, GIBS and COTTERS.
5. SPARE PARTS of CARRIAGES and WAGONS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Locomotive Turntables," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 27th May, 1927.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specifications Nos. 1, 2, 3 and 4, and of 5s. for each copy of Specification No. 5.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1,
11th May, 1927. 5481

The Madras and Southern MAHRATTA RAILWAY COMPANY, Ltd., 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for—

(1) 500 STEEL AXLES for Carriages and Wagons (Metre Gauge).
(2) 1800 Tons PIG IRON (Scotch No. 3).

Tenders are due in as follows :—

No. (1) by 2 p.m. on Tuesday, 31st May, 1927.
No. (2) by 10.30 a.m. on Wednesday, 1st June, 1927.

Tender forms obtainable at above address ; fee ONE GUINEA each, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 5451

PUBLIC NOTICES

Kilkenny County Council. TENDER is hereby INVITED for the following :—

(A) RE-SURFACING with BITUMEN MACADAM of 960 PERCHES of ROAD between the Municipal Boundary at Kilkenny and the Cross Roads at Grovine.
Surface area to be treated 35,200 square yards.
(B) RE-SURFACING with BITUMEN MACADAM of 960 PERCHES of ROAD between the Municipal Boundary at Kilkenny and Cuffesgrange Village.
Surface area to be treated 35,200 square yards.

Copy of specification and further particulars may be obtained on application to the Acting County Surveyor.

Tender should be lodged with the undersigned not later than Tuesday, the 17th May.

THOMAS DREW,
Secretary.
Court House, Kilkenny. 5441

Trinity House, London.

The Corporation of Trinity House, the General Lighthouse Authority for England and Wales, will shortly have a VACANCY for a SURVEYOR OF SHIPPING.

Candidates should be about 35 years of age and must possess marine engineering qualifications, and if possible hold a Board of Trade 1st Class Certificate as Engineer.

Salary, £500 per annum, for six months' probation and thereafter, if confirmed, £550 by £20 to £650, plus variable "cost of living" bonus (at present £196 on £500).

Pensionable post at Civil Service rates.

The Officer appointed must have a thorough knowledge of Wood, Iron and Steel Ship Construction. He will be responsible for the Overhaul and Repair of about Fifty Light Vessels and Nine Steam Tenders, including the preparation of specifications also for the preparation of designs and specifications for new light vessels and steam tenders.

Application to be made IN WRITING ONLY, with full particulars of training and experience, not later than 1st June, 1927, addressed to the SECRETARY, Trinity House, Tower Hill, London, E.C. 3, and endorsed "Application for Appointment as Surveyor." 5450

81 VOLS. MINUTES of PROCEEDINGS, INST. CIVIL ENGINEERS, 1898-1923. Bound cloth, perfect condition ; £8 or near offer.—CLARK, Bunningdale, Molesey. 5468

PUBLIC NOTICES

Engineering Exhibition, Cardiff.
Under the Auspices of
THE SOUTH WALES INSTITUTE OF ENGINEERS,
In the DRILL HALL (Dumfries-place), CARDIFF, from
NOVEMBER 22rd to DECEMBER 3rd, 1927
(both dates inclusive).
Open from 2.30 to 8.30 p.m. each day.

The Council of the South Wales Institute invite APPLICATIONS for SPACE in the above Exhibition. The last date for receiving applications is August 31st, 1927.

The Exhibition will comprise the following exhibits :—

SCHEDULE OF EXHIBITS.

SECTION 1.
Scientific, Measuring, and Recording Instruments, as applied to all branches of Engineering.

SECTION 2.—STEAM SECTION.
Water Softening and Cooling Plant.
Boilers and Equipment.
Pipes, Valves, Separators, &c.
Drawings or Models of Modern Engines.
Governors and Safety Devices, &c.

SECTION 3.—ELECTRICAL SECTION.
Motors of Various Kinds and Models of Winders.
Switchgear, Cables, Controllers, &c.
Electrical Tools and other Appliances.
Overhead Lines.
Small Motors.
Electric Cranes.
Telephones and Wireless Apparatus, &c.

SECTION 4.—MECHANICAL SECTION.
Mechanical Transmission of Power above and below ground, and Plant and Equipment connected therewith.
Bearings, Clutches, Ropes, Belts, Gearing, &c.
Air Compressing Plant.

SECTION 5.—WORKSHOP APPLIANCES.
Machine Tools (small).
Lathes and Drills.
Hydraulic Tools.
Woodworking Machinery, &c. &c.

SECTION 6.—GENERAL SECTION.
Shaft Signalling.
Devices to Prevent Overwinding.
Models of Pit Cages, Tram Tipplers, and Decking Devices.
Models of Coke Ovens, By-product and Recovery Plant.
Coal Cutting and Conveying Machines.
Pumping Plant.
Models of Screening, Coal Washing and Sorting, and Stone Dusting Plant.
Couplings.

SECTION 7.—METALLURGICAL SECTION.
Furnaces.
Plant for Steel, Copper, Nickel, &c., Manufacture.
Tin-plate and Galvanising Equipment.
Briquetting Machinery.
Rolls and Mill Work.
Adaptation of Tin-plates and Sheets to Commercial Uses.

SECTION 8.—MARINE SECTION.
Models of Marine Boilers.
Models of Marine Appliances for Loading and Unloading Ships.
Pneumatic Riveters.
Deck and Engine-room Fittings.
Oxy-acetylene Welding Plant, &c.

Forms of application for space, ground plan and other particulars will be forwarded on application to
MARTIN PRICE,
Secretary,
The South Wales Institute of Engineers,
Park-place, Cardiff. 5434

Sudan Government, Public Works Department, REQUIRE the SERVICES of a DISTRICT ENGINEER. Age 25 to 32, preferably single. Candidates should have had thorough civil engineering training and possess A.M.I.C.E. degree or equivalent. Design of structural steel work, &c., an added qualification. Commencing salary £E480 to £E540 per annum, according to age and qualifications (£E1 equals £1 0s. 6d.). Eighteen months' contract. Free first-class passage out and home. Progressive post if retained. Strict medical examination.—Apply by letter, giving details of education, training and experience, to ADVISORY ENGINEER, Sudan Government, London Office, Wellington House, Buckingham-gate, S.W. 1, marking envelope "District Engineer." 5476

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, TECHNICAL REPRESENTATIVE with connection among Heating, Drying and Textile Engineers and Architects in Lancashire and Yorkshire area to promote sale of Patent Air Heating Batteries of established reputation.—Reply, stating experience and qualifications, to D. F. THOMSON and CO., Ltd., 54, Victoria-street, Westminster, S.W. 1. P3159 A

CONSTRUCTIONAL STEELWORK DESIGNER REQUIRED in London Office ; able to produce Competitive Schemes of all classes quickly ; good knowledge of London Building Acts essential. Full particulars of experience, &c.—Address, 5455, The Engineer Office. 5455 A

SITUATIONS OPEN (continued) Page 2.

SITUATIONS WANTED, Pages 2 and 3.
PARTNERSHIPS, Page 3.
MISCELLANEOUS, Page 3.
AUCTIONS, Page 92.
EDUCATIONAL, Page 4.
AGENCIES, Page 4.
MACHINERY, &c., WANTED, Page 4.
FOR HIRE, Page 4.
FOR SALE, Pages 4, 8 and 92.
PATENTS, Page 4.
BUSINESSES and PREMISES (For Sale, etc.), Page 92.
WORK WANTED, Page 6.

For Advertisement Rates see Leader Page.

INDEX TO ADVERTISEMENTS Page 91.

SITUATIONS OPEN (continued)

ELECTRICAL ENGINEER REQUIRED for Engineering Works and Rolling Mill Plant in South Wales; must be fully qualified man with both theoretical and practical experience, preferably not over 35 years of age.—Address, with full particulars of experience and training, age and salary expected, 5460, The Engineer Office. 5460 A

EXPERIENCED ENGINEER REQUIRED, Age 25-30, under three years' agreement for Malay States, used and willing to undertake repairs, rewinding and installing Electrical Plant, and eventually to take charge of Diesel Engines. Salary £400, rising to £550. State age, experience, and salary required.—Address, P3156, The Engineer Office. P3156 A

FIRST-CLASS DESIGNER of REINFORCED CONCRETE STRUCTURES REQUIRED by specialist firm.—Address, stating full particulars and salary required, 5445, The Engineer Office. 5445 A

FOUNDRY MANAGER WANTED for Midlands, approximate output 30 tons per week grey iron. Must be able to make up quotations, fix piecework prices, and be familiar with green and dry sand, repetition and special work. Largest castings 6 to 7 tons. State age, experience, and salary required.—Address, 5438, The Engineer Office. 5438 A

HATHERLEY WORKS, Ltd., Gloucester.—Experienced MAN REQUIRED for MANAGEMENT; capable engineer with experience of Woodworking Machinery; knowledge of Foreign Timber and Sales.—Write, with full particulars, stating salary required, to A. W. GARDEN, 66, Gresham House, Old Broad-street, London, E.C. 2. 5475 A

HEAD CHARGE HAND for Hydraulic Press Shop WANTED; medium and light work, very varied, but chiefly in light plate. West Midlands.—Address, 5443, The Engineer Office. 5443 A

REQUIRED IMMEDIATELY, ENGINEERING MACHINE SHOP SUPERINTENDENT for Iron and Steel Works on North-East Coast; accustomed to modern production and the handling of labour under day and piecework conditions. State age and salary.—Address, P3167, The Engineer Office. P3167 A

SALESMAN REQUIRED, Preferably Residing South of the Thames, for De Laval Centrifugal Oil Purifiers, &c. Expert salesmanship combined with engineering and technical knowledge essential. Salary and commission. Good prospects.—Address, P3155, The Engineer Office. P3155 A

SHOPS SUPERINTENDENT WANTED for General Engineering Works near Manchester, with Foundries, Light and Heavy Machine Shops, Fitting and Erecting Shops, normally employing 600/700 men, largely on heavy work. Good opening for a first-class practical man with energy, tact, and initiative. Must have knowledge of up-to-date methods and be able to obtain maximum output at lowest cost. Address, stating age, salary, and full particulars of experience, 5446, The Engineer Office. 5446 A

WELL-EDUCATED YOUNG ENGINEER, with literary ability, to Write Articles and Prepare Publicity Matter for Chemical Engineering Company. State experience and salary required, and submit specimens of work.—Address, 5433, The Engineer Office. 5433 A

WANTED for Australian Engineering Works, Competent ENGINEERING DRAUGHTSMAN; preference to one having experience Chain Drive Design. Good salary, three years' contract and passage out.—Address, with full details as to education and experience, 5477, The Engineer Office. 5477 A

DRAUGHTSMAN, Mechanical, Experienced in Pipe Lay-outs for Cooling Systems, also well versed in Steel Tank Design and Construction.—Address, with particulars of age, experience, and salary required, 5437, The Engineer Office. 5437 A

DRAUGHTSMAN REQUIRED for Engine Detail Work. Preference given to one experienced in Air Compressor design.—Address, stating age, experience, and salary required, 5411, The Engineer Office. 5411 A

DRAUGHTSMAN REQUIRED, Experienced in the Design of Water-tube Boilers and Accessories, both for land and marine work. Applicants must give full details of past experience, stating age and salary expected.—Address, 5456, The Engineer Office. 5456 A

DRAUGHTSMAN REQUIRED, One Used to Refrigerating Work and Dairy design preferred.—Address, stating full particulars and salary required, 5479, The Engineer Office. 5479 A

DRAUGHTSMAN, Single, Age 22 to 25, WANTED for Sumatra; General Engineering experience and familiar with design and construction of Structural Steel Work. Commencing salary £400 per annum.—Write, giving full particulars of experience, to Box No. 237, c/o Judd's, 47, Gresham-street, London, E.C. 2. 5469 A

DRAUGHTSMAN WANTED, Thoroughly Experienced in the Design and Lay-out of Modern Coal and Ore-handling Plant.—Write, stating age, full particulars of experience and salary required, to FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 5467 A

DRAUGHTSMAN, with Experience in Design of Commercial Motor Vehicles and Passenger 'Buses, REQUIRED IMMEDIATELY, Leeds district. State age, experience, and salary.—Address, 5474, The Engineer Office. 5474 A

HEATING DRAUGHTSMEN REQUIRED, Capable of Designing and Supervising Modern Hot Water and Steam Central Heating Installations. Only experienced men need apply. Senior and Junior required.—Address, 5459, The Engineer Office. 5459 A

JUNIOR DRAUGHTSMAN, with Knowledge of Refrigerating Machinery; London.—Address, 5464, The Engineer Office. 5464 A

SEVERAL DETAIL DRAUGHTSMEN REQUIRED AT ONCE in London district; experience in Motor Car Industry desirable. Applicants should state age, previous experience, salary required and when at liberty.—Address, P3174, The Engineer Office. P3174 A

SITUATIONS OPEN (continued)

TWO First-class CIVIL ENGINEERING or STRUCTURAL DRAUGHTSMEN REQUIRED for temporary work in a Railway Office in London.—Address, stating age, experience, and salary required, 5432, The Engineer Office. 5432 A

YOUNG DRAUGHTSMAN WANTED for Large Wood-working Factory, to Prepare Machine Lay-outs, &c., under supervision of engineer. Experience of Building Construction desirable.—Address, stating age, experience and salary required, P3165, The Engineer Office. P3165 A

YOUTH REQUIRED in London Office with Technical training and knowledge of drawing. State age, full particulars, and salary.—Address, P3186, The Engineer Office. P3186 A

REQUIRED by a European Firm of Structural and General Engineers in India, an ASSISTANT FOREMAN in their Structural Department. Applicants must have experience in Template Making and be accustomed to Bridge, Roof and General Structural Work. Must be a bachelor and not more than 26 years of age.—Apply, stating age and full particulars of experience, to Z.B., 299, care Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 5483

SITUATIONS WANTED

WANTED, POSITION in Engineer's Office or in Works. Living wage leading to responsible post by young European practical and technical engineer at present in India. Fluent knowledge language. No objection undergoing specialised training at home. State terms, &c., in first letter.—Address, P3158, The Engineer Office. P3158 B

A COMMERCIAL ENGINEER (30), A.M.I.C.E., A.M.I.M.E., workshop, design, inspection and sales experience with power plant and machinery, REQUIRES POSITION as Sales Manager or Representative. Excellent business record. — Address, P3153, The Engineer Office. P3153 B

A.M.I.M.E. (India), 8 Years' Eastern Experience, 3 years' commission, R.N.R., DESIRES APPOINTMENT abroad. Excellent references and experience in mechanical engineering. Water-tube boilers and accessories a speciality.—Apply, Box 605, Robertson and Scott, Edinburgh. P3179 B

APPOINTMENT as PROGRESS MANAGER; considerable experience and exceptional organising ability.—Address, P3182, The Engineer Office. P3182 B

SITUATIONS WANTED (continued)

A SPECIALITY SALESMAN ENGINEER, A.M.I.E.E., widower (45), with extensive home and continental experience, excellent linguist, fluent French, German, Dutch, Spanish, &c., DISENGAGED, SEEKS SUITABLE POSITION with first-class British firm, at home or abroad.—Address, P3178, The Engineer Office. P3178 B

ASSIST. WORKS MANAGER (33), 17 Years' First-class exp. production of automobiles, electrical and general engineering work.—Address, P3181, The Engineer Office. P3181 B

BUYER (42), Sound Experience in Engineering stores purchasing and production, technical and commercial knowledge, genuine organising ability, capable of exercising reliable independent judgment, well educated, good correspondent.—Address, P3185, The Engineer Office. P3185 B

For continuation of Small Advertisements see page 3.

Rust means weakness——
strength is the essential of these mammoth cranes

A crane has to be strong to lift 150 tons—one weak spot means danger. Reared high in the air, exposed to wind, rain, sun, fumes etc., such structures need perfect protection against corrosion.

For more than 70 years "Bitumastic" has been defeating the ravages of the elements. Rust cannot be, where the surface is protected with "Bitumastic"—oil and water might just as well be expected to strike up a friendship.

Leading engineers the world over know and use "Bitumastic"—the perfect corrosion eliminator. It is efficient, economical and almost everlasting.

Our descriptive booklet will help you overcome your corrosion problems—let us send you a free copy.

BITUMASTIC REG^D

SOLE MANUFACTURERS:

WAILES DOVE BITUMASTIC LTD. (Department P.), NEWCASTLE-ON-TYNE

PECKETT & SONS, Ltd., Bristol

Telegrams—PECKETT, BRISTOL. London Representatives: FERGUSON & PALMER, 9, Victoria Street, Westminster, S.W.1.

Speciality

TANK LOCOMOTIVES

of all Descriptions, and any Size or Gauge.

FULL PARTICULARS ON APPLICATION.

A Seven-Day Journal

Trade Facilities Acts Guarantees.

AN official statement of the guarantees under the Trade Facilities Acts which the Treasury has given up to the completion of the scheme on March 31st, has now been published. It shows that the total sum guaranteed is now over £74,250,000, of which more than £2,045,000 has been repaid within the last two years. Among the new guarantees connected with shipbuilding is a further £133,000 for the New Zealand Shipping Company, Ltd., and also £106,000 for the Rederiet "Belmoira" Aktieselskap, for the construction of two locomotive carrying vessels at Newcastle-upon-Tyne. Other ship-owning companies have received guarantees in respect of new ships as follows:—The Sheaf Steam Shipping Company, Ltd., £70,000 for one vessel; Coastal Tankers, Ltd., £17,000 for one vessel; and Steaua Romana £84,000 for one ship. Four new ships are to be built by the Prince Line, Ltd., and four by the American-Levant Line, Ltd., for which guarantees of £840 000 and £250,000 respectively have been made. Among the harbour and dock schemes we note an additional guarantee of £60,000 for the Workington Harbour and Dock Board and £75,000 for the Ipswich Dock Commission. An additional sum of £750,000 has been guaranteed to the African Railway Finance Company, Ltd., for harbour work connected with the Benguella Railway, and for the purchase of rolling stock, plant and machinery. Guarantees connected with mining and colliery work include a new sum of £76,500 for the Appleby Iron Company, Ltd.; £400,000 for Pease and Partners, Ltd., for the developing of Thorne Colliery; £250 000 for the Sheffield Coal Company, Ltd.; £450,000 for Londonderry Collieries, Ltd.; and an additional sum of £15,000 for Dalcoath Mines, Ltd. The remaining industrial guarantees include a sum of £100,000 for Fuel Production Company, Ltd., for the erection of low-temperature carbonisation plant, and an additional £5000 for Pickerdite and Co., Ltd., for machinery and plant, as well as £250,000 for the Palestine Electric Corporation, Ltd., for the purchase of plant in Great Britain for an hydro-electric undertaking in Palestine.

The Nag Hamadi Nile Barrage.

As was foreshadowed in our Journal note of April 29th, the contract for the construction of the Nag Hamadi barrage, some 30 miles below Luxor, has been placed with Sir John Jackson, Ltd., of Westminster, whose tender of £E1,976,621, was the lowest of the many submitted. The total length of the masonry barrage is to be 2500ft., and there will be 100 sluice gates, through which the waters of the river Nile will pass. About three years will be required for the completion of the work. It will be necessary to create practically a new town to accommodate the men who will be employed on the construction of the barrage, and this town will be complete with electric light, water, fuel, and hospital facilities. For the actual work, cableways from bank to bank will be employed, and they will, we learn, probably be among the largest ropeways ever constructed. In order to provide the necessary stone and granite, large quarries are to be established, both upstream and downstream of the dam site. The material will be transported by a fleet of river craft. Work will be carried on during the—low Nile—period which extends from December to July, after which month the flood water, of course, renders further work on the river impossible. The plans for the barrage have been prepared by Messrs. Coode, Fitzmaurice, Wilson and Mitchell, of Westminster, who are the consulting engineers appointed by the Egyptian Government.

The New French Tariff.

AT the time when the new Tariff Bill is being brought up for debate in the French Chamber of Deputies, it is the object of a strong indictment on the part of influential bodies representing the commercial interests of the country. The protest is made a little too late, and an appeal to the Government to hold back the Bill until it has received full consideration from all classes is not likely to meet with the desired response. The new tariff has undergone so many changes during its long period of preparation, with a view ostensibly of settling upon a moderate form of protection, that its final repressive character is causing considerable surprise. After going through the 8000 items of the tariff it is found to be much more prohibitive than had been supposed, and the commercial interests declare that if the Bill is passed it will be disastrous for the country, because it will increase the cost of living, at a time when every effort is being made to bring it down, and also because it will inevitably provoke retaliation from other countries and ruin the foreign trade which is the great source of the country's prosperity. The "balance of trade" is particularly favourable to France, since the imports consist mainly of raw material and the exports, which are of greater value, are largely of manufactured goods. It is further alleged that the Customs Commission has, in many cases, increased import duties to far beyond the maximum which manufacturers had declared to be necessary for their protection. The Government is making haste to carry the Bill through so as to be able to resume negotiations with Germany for a treaty of commerce within the limit of time fixed by previous temporary arrangements. Tariffs have been put up to a high level in the hope of securing advantages from Germany and making a treaty on terms that will provide for the industrial salvation of the restored provinces. In a word, the commercial interests in France affirm that the Tariff Bill is a prohibitive measure which, in its present form, is likely to defeat its own ends.

The Blue Star Liner Avelona.

ON Friday of last week, May 6th, the new Blue Star liner Avelona—a sister vessel to the recently completed Avila, which was also built and engined by John Brown and Co., Ltd., at Clydebank—ran successful speed trials in the Firth of Clyde. Although contract conditions called for a speed of 16 knots, the mean speed over the measured mile at Skelmorlie worked out at 17·14 knots, or a very full knot over the contract speed. We also understand that the Avila, which is now completing her first round voyage, promises to give particularly good results. The Avelona is similar in design to the Cammell Laird-built Almeda, which, together with her refrigerating machinery, was described and illustrated in our issues of December 31st, 1926, and April 8th, 1927. She has a length of 510ft., with a measurement of 14,000 gross tons, and is propelled by Parsons type, twin-screw, single-reduction geared turbines, designed for a total output of 7600 S.H.P., and constructed by the builders of the ship. Refrigerating machinery and insulated hold space is provided for the carrying of some 4000 tons of chilled meat in the company's South American service. Unusually fine accommodation for 180 first-class passengers is provided, and a special feature of the ship is to be found in the decoration of the public rooms, which have been supervised by Sir Charles Allom. At the luncheon which followed the trial, over which Sir Thomas Bell presided, and at which Lord Vestey, chairman of the Blue Star Line (1920), Ltd., and Lady Vestey were present, Mr. Leonard Dewey, the manager of the line, referred to the growth of the Blue Star fleet. Ten years ago the tonnage of the fleet was, he said, in the neighbourhood of 50,000 to 60,000 tons; but to-day it was about 225,000 tons.

The University of London.

THE unanimous decision of the Senate of the University of London to acquire from the Duke of Bedford the whole of the University site in Bloomsbury ends in a happy way a controversy which has lasted many years. The decision was announced by Lord Eustace Percy, President of the Board of Education, at the graduation dinner of the University, which took place on Thursday evening, May 12th, over which the Vice-Chancellor of the University, Sir William Beveridge, presided. The formal contract of purchase has yet to be completed, but it is stated that agreement has been reached on all essential details. It was further announced by Lord Percy that the purchase has been made possible partly by the use of a limited grant which was promised to the University by the Chancellor of the Exchequer in July last, and partly by a munificent contribution from the Rockefeller Foundation. It is understood that in taking this new and important step the Senate will not be burdened with any conditions as to the surrender of anything which it now holds, either at King's College or at South Kensington. The new site lies immediately to the north of the British Museum and, together with roads, embraces some 11 acres.

The William Froude National Tank.

THE recently published report of the Advisory Committee for the William Froude National Tank for the year ended December 31st, 1926, bears testimony to the excellent work which is being done at Teddington in connection with experimental research in ship propulsion. During the year 1926, which is the period under review, no less than sixty-three models, representing thirty-three different designs were tested for shape of hull, which is a gratifying increase over the numbers for previous years. Of these designs, twenty-four were tried with propellers, and the forms included tankers, dredgers, cross-Channel and coastal vessels, as well as forms for smaller craft and passenger liners with twin and quadruple propellers. Some of the propeller tests were made with a new apparatus, in which the propellers were driven from inboard the model by electric motors, and during the year a new method of determining the best shape of propeller bosses was adopted. The aeronautical work included the testing of eleven models of seaplanes and flying boats. Among the research work is that dealt with by Mr. Kent on the influence of waves on the resistance, propulsion and pitching of ships, which is described in his paper read before the Institution of Naval Architects, a summary of which was given in our issue of April 22nd. Some work has been done on manœuvring of ships, and comparative trials of a 9·6in. diameter model screw of mercantile form have been run at the National Tank and also at the Hamburg Tank. With the exception of the special trials of H.M. destroyer Ambuscade, no steam trials were attended by the tank staff during 1926, but the returns of five different ships were examined and four sets of measured mile data were analysed. The report concludes with a statement as to the proposed programmes of research on friction, screw propeller work, the wave resistance of three-dimensional forms, wind resistance of hull and superstructure, and the influence of waves on the resistance propulsion and pitching of ships. The summary given in the report we have referred to makes clear the service which the National Tank is rendering to industry, and emphasises the necessity for the maintenance of steady progress with ship research.

S. Pearson and Son (Contracting Department) Ltd.

THE firm of S. Pearson and Son (Contracting Department), Ltd., announces that it has decided not to compete for any new contracts. Actually, this decision was made some time ago, and since the conclusion of the Sennar Dam no new tenders have been sent out. The work which it now has in hand, which includes the port works at Valparaiso and the construction of the dam in the Silent Valley for the Belfast City and District Water Commissioners, are now under the control of Sir Ernest Moir, Bart., M. Inst. C.E., who has been associated with the firm of Pearsons for over thirty-eight years. These contracts will, of course, take some years to complete, and the contracting department of the firm will continue in being until they are finished. The decision to close down this branch of the firm of S. Pearson and Son will in no way interfere with the other branches of the same undertaking, which, as is well known, includes electrical, oil, land and financial interests, all of which sections of the business will continue to operate as heretofore.

Oil Pollution of Coastal Waters.

FRUITFUL results have attended the international conference which was held at Washington in June, 1926, to investigate the problem of the pollution of navigable waters by the discharge of oil. It is announced in Admiralty Fleet Orders this week that the recommendations of the Conference have been accepted in principle by H.M. Government. British shipowners are voluntarily giving effect to the main provision that oil should not be discharged within 50 miles of a coast. Compliance with this rule should go far to prevent the pollution of fishing grounds and the destruction of sea birds, the latter having been not the least deplorable consequence of the indiscriminate discharge of oil from ships. A source of great inconvenience and hardship to coastal dwellers will also be eliminated. Although the Convention has not yet been ratified, the rule forbidding the discharge of oil within 50 miles of land is henceforth to be observed by warships and auxiliaries of the Royal Navy, subject to the exigencies of the service. It applies to crude, fuel or Diesel oil, as also to any mixture containing more than ·05 of 1 per cent. of such oil, or having a content of such oil sufficient to form a film on the surface of the sea visible to the naked eye in daylight in clear weather. The respective Governments which are parties to the Covenant may establish prohibited discharge areas in waters adjacent to their coasts, but not beyond a distance of 50 nautical miles, save in special instances, *e.g.*, where the configuration of the coastline renders that distance inadequate, in which case the area may be extended to a width not exceeding 150 nautical miles. Arrangements have been made for the exchange between the various Governments of information relating to prohibited discharge zones and of other data bearing on the subject of oil pollution and remedial measures. It will be seen that definite progress has been made in dealing with a problem of considerable importance to all maritime communities.

London's Cross-River Bridges.

ACCORDING to correspondence which has recently passed between the Prime Minister and the London County Council, it would appear that a beginning will shortly be made in the application of the proposals made by the Royal Commission on Cross-River Traffic, which was presided over by Lord Lee. In Mr. Baldwin's letter, particulars of the financial assistance which will be offered by the Government are given, and the projects for the reconstruction of Waterloo Bridge, the construction of the double-decker bridge at Charing Cross, the Victoria Dock-road, and the Lambeth Bridge, are referred to. In the City, the Bridge House Estates Committee is proceeding with the examination of the proposal for a Ludgate Hill bridge, which was recommended by the Royal Commission in the place of St. Paul's Bridge. In a little over two months it is hoped that a report will be ready to present to the Court of Common Council.

20,000 K.W. Parsons Turbo-Alternator at Rotterdam.

No. I.

THE Schiehaven power station of the city of Rotterdam, with its 85,000 kilowatts of generating plant installed, ranks as one of the most important in Holland. Except for the power contributed by a very small plant at Maashaven, the Schiehaven station supplies the whole of the electrical needs of the city. Last year the net electrical output of the undertaking reached 135·796 million kilowatt-hours, and the healthy growth of the load is shown by the fact that these figures represent an increase of 35 per cent. over those for 1925, which, in turn, were better by 14 per cent. than those of the year before. Of the total output, about 50 per cent. is supplied for power purposes, and 10 per cent. for the tramways of the city, the remaining 40 per cent. being utilised for lighting and heating. The load factor is by no means high, being about 25·6 per cent. only, calculated on net output. The Schiehaven station, nevertheless, produces a saleable kilowatt-hour for an average of 4720 calories, or about 18,700 B.Th.U. in the fuel. The annual overall efficiency is therefore about 18·2 per cent., though during five days in the week efficiencies as high as 20 or 21 per cent. are obtained. The fuel consumption per annum under present conditions works out to 0·642 kilos. per kilowatt-hour, the average boiler-house efficiency being 78·2 per cent. These results are obtained with the quite moderate steam pressure of 200 lb. per square inch at the boilers, and a steam temperature of 716 deg. Fah.

The engine-room contains seven turbo-generating sets, delivering three-phase current at 5000 volts and 50 cycles. The machines are all of the reaction type, ranging in size from 5000 to 20,000 kilowatts maximum continuous rating. By the courtesy of C. A. Parsons and Co., Ltd., and with the ready consent of Mr. Ehrenburg, the director of the Rotterdam undertaking, we are able to place before our readers a very full description of the 20,000-kilowatt set recently supplied by Messrs. Parsons to the Schiehaven station. The general arrangement of the unit is illustrated in elevation and plan in Figs. 1 and 2 respectively, while in our Supplement of to-day are given longitudinal sections through the turbine and the alternator. The turbine is a pure reaction machine. It consists of two cylinders arranged in tandem directly coupled to the alternator and to the exciter. The high-pressure cylinder, as will be seen by the section, is of the ordinary single-flow design, while the double-flow principle is employed in the low-pressure cylinder to enable the large volume of the low-pressure steam to be effectively dealt with. The speed of the set is 3000 revolutions per minute, and the most economical load is 16,000 kilowatts, although, as has been stated, the machine will carry continuously a load of 20,000 kilowatts without undue temperature rise.

The turbine is designed for steam at 12 kilos. per square centimetre (170·6 lb. per square inch) gauge pressure at the stop valve, superheated to a temperature of 350 deg. Cent. (662 deg. Fah.). With cooling water at 15 deg. Cent. (59 deg. Fah.) the absolute condenser pressure at full load is 1·2in. of mercury, corresponding to a vacuum of 28·8in. with the barometer at normal height. Under the stipulated steam conditions the guaranteed consumption of steam and of heat at various loads is given by the following table:

Load, kilowatts.	Temp. of feed to hotwell, deg. Cent.	Steam consumption, kg. per kwh.	B.Th.U. per kwh.
20,000	100	5·165	13,430
16,000	100	5·035	13,090
12,000	95·5	5·170	13,560
8,000	87·8	5·447	14,430

These steam and heat consumption figures include the power required for the alternator ventilating fan. For purposes of guarantee the mean steam consumption was calculated on the assumption that the machine ran for one hour at 20,000 kilowatts, two hours at 16,000 kilowatts, and 12,000 kilowatts respectively and one hour at 8000 kilowatts. Under these conditions the guaranteed mean steam consumption works out to 5·17 kilos. (11·395 lb.) per kilowatt-hour, a figure which was considerably improved upon at the official test.

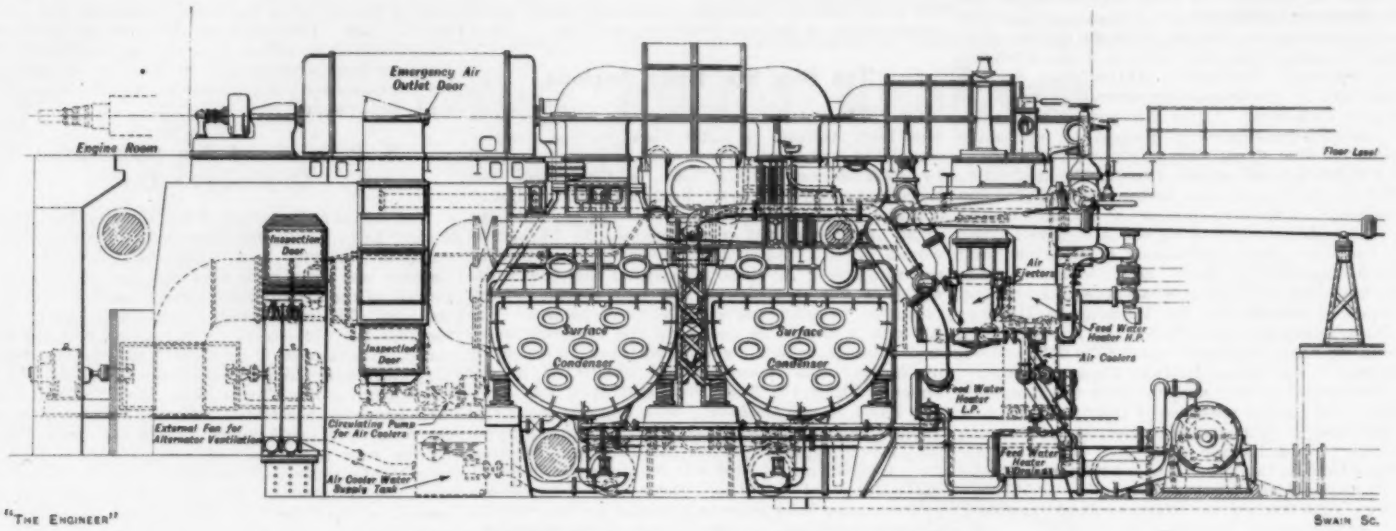


FIG. 1—SIDE ELEVATION OF 20,000 K.W. TURBO-ALTERNATOR

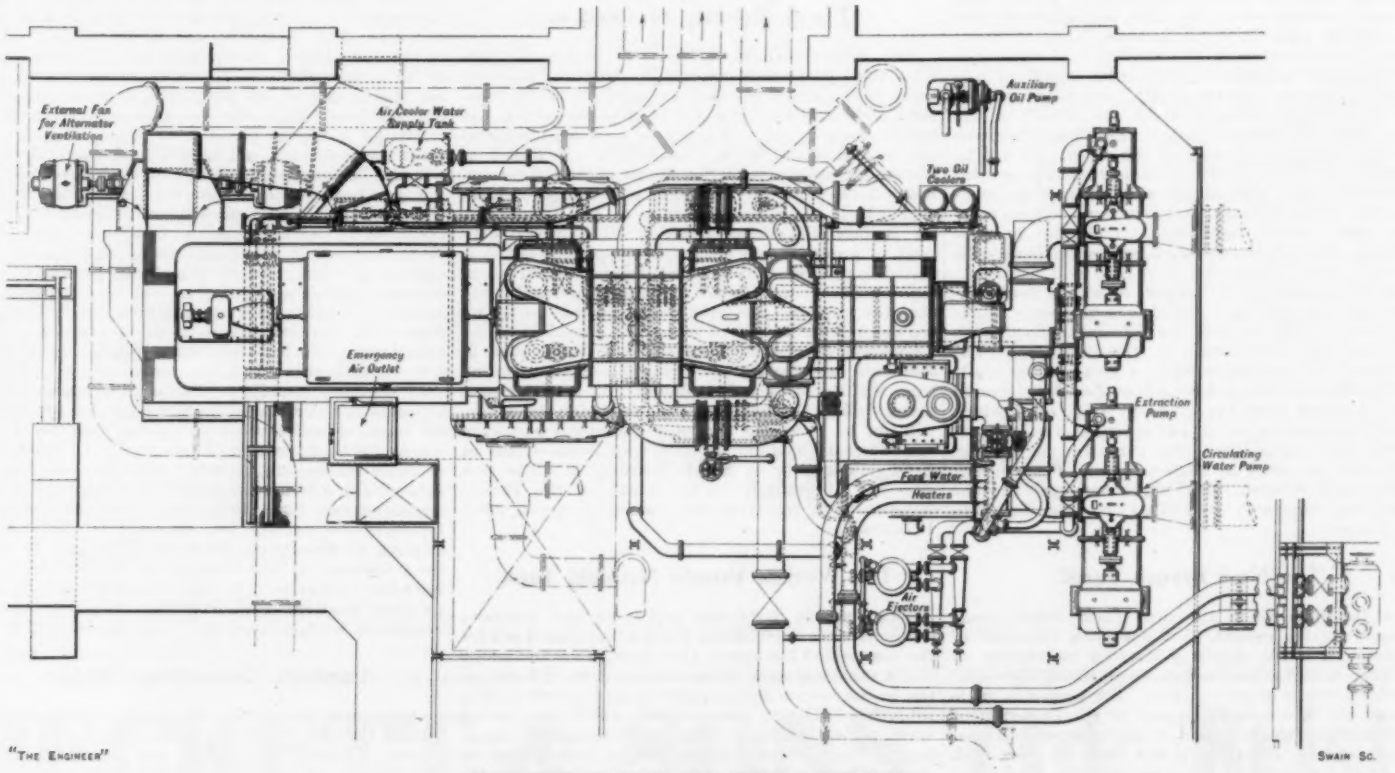


FIG. 2—PLAN OF 20,000 K.W. TURBO-ALTERNATOR

The complete turbine, regarded as a thermodynamic machine, consists of thirty-four rows of moving blades in series. Of these, twenty-six are contained in the high-pressure cylinder, the remaining eight rows being duplicated by the double-flow arrangement adopted in the low-pressure cylinder, so that actually there are forty-two rows of running blades. The high-pressure blades are distributed over three drum diameters, namely 19·25in., 25·25in. and 33·25in. respectively, and corresponding to each diameter is a dummy piston to balance the end thrust of the steam on the blading of that diameter. The whole

of the high-pressure rotor, including dummies, bearings, &c., is machined from a solid steel forging, which was carefully heat treated both before and after rough-machining. The low-pressure rotor is similarly made from a single forging, both being bored through from end to end with a central axial hole large enough to permit of the physical state of the metal at the centre of the forgings to be examined by means of a suitable instrument called a "Borescope." It is Messrs. Parsons' standard practice to bore all their turbine rotors in this manner as a means of verifying the soundness of the forgings. The largest diameter of the low-pressure rotor is 41·5in., and the bladed portion is divided into six sections by means of deep under-cut grooves in the manner shown. The two rotors are connected by a flexible coupling of the castellated type, with arrangements for ample lubrication of the claw faces. The bearings are of the self-aligning type lined with white metal, those of the high-pressure rotor being 8in., and those of the low-pressure rotor 9in. diameter, with a length of 12in. in each case. Each rotor is also provided with a thrust bearing of the single collar type, with pivoted thrust pads. The function of these bearings is primarily to ensure the correct axial positions of the respective rotors, for under normal conditions each rotor is automatically balanced against end thrust. The thrust block of the low-pressure rotor is held fast in the pedestal housing, but that of the high-pressure rotor is provided with an axial adjustment, which can be set by a hand wheel outside the casing. The object of this adjutment is to regulate the "end tightening" of the blading, a subject which we shall refer to later.

The glands which serve to prevent leakage where the shafts leave the cylinders are all of the carbon ring type. Each gland consists of four segmental carbon rings, accurately machined and fitted and held on the shaft by garter springs of steel wire, heat treated and coated with copper to prevent corrosion. The rings are contained in cast iron housings, with annular pockets for the sealing and the leak-off steam. The supply of sealing steam is controlled by valves on the admission side of the steam chest, the connections to the several glands being made by solid-drawn steel pipes with welded-on flanges. The sealing steam is admitted between the inner pair of rings and the leak-off takes place between the outermost pair.

The driving of the oil pumps, governor and tachometer is effected by a worm gear at the end of the high-pressure turbine shaft. The worm drives a horizontal cross shaft, at one end of which is the governor and at the other a pair of bevel wheels driving the vertical shaft for the tachometer and oil pumps. There are two oil pumps of the gear wheel type, both housed in the same casing. One of these pumps supplies the high-pressure oil for the oil relay gear, and the other the oil for lubricating purposes. All parts are very accessible, and the whole governor assembly can be withdrawn by removing the end cover of its casing, and without dismantling any other parts. The governing is very sensitive, as not only is the governor amply powerful, but all it has to do is to determine the position of a small balanced pilot valve that controls the admission of oil to the relay cylinder which operates the regulating valve. The governor levers are machined and electro-plated, and the pins are case-hardened and ground. At the extreme end of the turbine shaft is an independent overspeed governor, which shuts the machine down should the speed rise beyond a predetermined limit. This governor consists of a bolt which is normally held in position by a spring, but overcomes by its centrifugal force the constraint of the spring should the speed of rotation become high enough. Its head then projects from the shaft and strikes a lever which trips an independent spring-loaded run-away valve, and at the same time releases the oil pressure controlling the regulating valve. Steam is thus doubly shut off, as these two valves are in series on the steam flow. The overload valve is operated by the same mechanism that controls the regulating valve. When the latter valve is open sufficiently to pass all the steam coming to it, without restriction, any further opening would not, of course, serve to increase or maintain the speed of the turbine. The continued motion of the valve, however, under the action of the governor, causes its spindle to act on the overload valve in the upper part of the high-pressure turbine casing by means of a system of levers. This valve, which is of the balanced double-beat type, is thus lifted from its seat, and high-pressure steam is thus allowed to pass from the inlet annulus of the turbine to a second annulus, a little way along the rotor. By this means the first seven blade rows of the rotor are short circuited and put out of action, and the turbine will produce a greater power, though at a slight sacrifice of efficiency, because of the greater steam flow through the rest of the blading. With normal conditions of steam pressure and vacuum, this overload valve will begin to open when the load on the turbine is about 16,000 kilowatts.

The whole of the blading throughout the turbine, whether fixed or moving, is of mild steel. The blades of the rotors, which are, of course, subject to centrifugal stresses from which the stator blades are free, are all of the "integral" type, that is to say, each blade together with its spacer consists of one solid piece of steel. These blades are formed by special rolling methods developed by the Parsons company. The process results in the grain of the metal being worked in the right direction to resist the stresses which the blades have to withstand in service, and ensures an accurately formed and very strong blade, with an ample radius at the junction of the blade and root. The blade roots and spacer pieces are heavily serrated along the sides, the serrations having a radius and pitch to correspond with similar serrations turned in the sides of the blading grooves in the rotors. Lantern spaces are cut in each of the rotor grooves to permit of the insertion of the blades, and the latter are driven round in the grooves till they are tightly together. The concave surface of the blade roots is rolled to a slightly smaller radius than the convex side, so that when the blades are driven up together, as has been mentioned, the roots spread slightly, and thus become a tight fit on the grooves. The lantern space is finely filled in with a piece of mild steel. The whole construction gives an immensely strong and accurate blading system for the rotors.

The blading for the casings is made in a different fashion. The blades are cut from steel strip to the required lengths and drilled near their ends for the reception of a root wire. The spacing pieces, also cut from steel strip of suitable section, are similarly drilled. Sufficient blades and spacer pieces are then assembled on a wire to constitute a short segment of blading. This is assembled in a former, curved to the radius required, and after assembly the segment of blading is removed from the former and the bottoms of the blades, and the spacer pieces immersed in fused borax, and then, without coming into contact with the air, they are dipped into molten brass. The whole segment is thus brazed solidly together. The sides of the root of the segment are then serrated. The grooves in the casing are provided with corresponding serrations, but the grooves are wider than the blade roots. The segment can therefore be inserted at any point, and after insertion it is tightened in position by means of short serrated side-locking pieces which are driven up circumferentially.

In the high-pressure cylinder the principle of "end-tightening" is adopted throughout. This enables the small clearances over the blade tips, which were characteristic of the earlier reaction machines, to be entirely done away with. The object of keeping the clearance at these points so small was, of course, to reduce the steam leakage from stage to stage along the turbine. At the high-pressure end of a turbine, however, where the steam density is high and the blades are comparatively short, the radial clearance which was necessary for the safety of the blading in case of distortion of the casing or vibration, was too great to permit of the highest efficiency being obtained. At the low-pressure end where the steam has a large volume and the blades are longer, a reasonable clearance can be allowed without the leakage becoming serious. To combine small leakage losses with ample blade-tip clearance at the high-pressure portion of a turbine, the principle of end-tightening was introduced by C. A. Parsons and Co., Ltd. To carry the idea into effect the blade rows are shrouded by strips of metal punched to fit over the tenoned ends of the blades. The shrouding strips are put on in short separate lengths with overlapping ends to allow freedom for expansion, and are brazed to the tenons of the blades. The ring of shrouding so formed overhangs the blade row on one side and its edge runs nearly in contact with a continuous flat surface formed by the side of the blade roots of the neighbouring row. Any leakage therefore has to find its way between the sharp edge of the shrouding and a flat surface which can be easily and safely adjusted to run extremely close to it. This adjustment is effected by a fine screw device which controls the position of the high-pressure thrust block, and thus determines the axial setting of the high-pressure rotor. It will be noted that with an "end-tightening" rotor, there is no restriction on the radial clearance which may be allowed at the blade tips.

In the case of the blading of the low-pressure cylinder, "end-tightening" is not adopted, for, apart from the greater difficulty of incorporating it in a double-flow turbine, it is quite unnecessary. The low temperature of the steam in this cylinder practically obviates all danger of distortion of the casing, and, furthermore, a perfectly adequate clearance can be allowed without the leakage steam amounting to any appreciable proportion of that doing useful work on passing through the blades. The blades therefore are not shrouded, but are thinned down to a sharp edge at their tips, so that in case of contact accidentally occurring the thin edge is instantly worn away without any danger to the blading. The difference between the two methods of blading will be seen from Figs. 3 and 4, page 524, the first of which shows the appearance of the top half of the high-pressure cylinder and the second that of the low-pressure rotor, both fully bladed.

The whole of the cylinder of the high-pressure turbine is of cast steel, and its free expansion is provided for by supporting the high-pressure end on a machined stool with substantial slipper guides to ensure the maintenance of correct alignment. The steam chest, containing the steam strainer, run-away valve and governor valve, is also of cast steel, and is connected to the turbine by flexible steel piping. The connection is made to the underside of the high-pressure casing, and the steam passes to the overload valve by the inlet annulus, so that there are no pipe connections to the cover of the cylinder. The turbine can thus be opened with the minimum of time and trouble. In accordance with Messrs. Parsons' practice, the use of cast or forged steel for all parts subject to the action of high-pressure steam has been adopted. The main stop valve, which is of the full-way type, with renewable seats, is of cast steel; the steam strainer is of forged steel with drilled holes; the run-away valve, of the mushroom type, is a steel forging solid with its spindle; while the double-beat governor valve and overload valve, as well as their seatings, are made from mild steel forgings. Those who have had trouble with turbine casings distorting or cracking and valves breaking or sticking owing to the action of superheated steam on cast iron will understand to what a great extent reliability and safety are ensured by the replacement of that material by steel.

As has been mentioned above, the complete turbine contains thirty-four stages. The first blade row is 2 $\frac{15}{16}$ in. high, with a mean diameter of 22 $\frac{15}{16}$ in., while the last blade rows are 13$\frac{1}{4}$in. high with a mean diameter of 51$\frac{1}{4}$in. Provision is made for "bleeding" the turbine for feed-water heating, which is done altogether in four stages. In the first stage, assuming full load is on the turbine, the condensate is heated from 80 deg. Fah. to 85 deg. Fah. by means of the heat recovered from the steam used to operate the air ejector. In the next stage the temperature of the feed water is raised from 85 deg. to 90 deg. Fah. by condensed steam from the drains. A third stage in heating is effected by tapping of steam from the turbine at a pressure of 4·4 lb. absolute. This raises the feed water to 140 deg. Fah. Finally, steam tapped from the turbine at a pressure of 23·4 lb. absolute raises the feed temperature to 212 deg. Fah., at which temperature it is delivered to the boilers.

As will be seen from the illustrations, twin condensers are employed. They are set transversely to the turbine, one directly under each exhaust branch of the low-pressure cylinder, the whole arrangement being compact and accessible, and demanding the minimum of head room on account of the form adopted for the condensers. The latter are mounted on springs in accordance with modern practice, this arrangement obviating the necessity for bellows pieces between the turbine and the condensers. Each condenser has an external tube surface of 12,000 square feet, and when supplied with 9800 gallons of cooling water per minute at a temperature of 59 deg. Fah., the pair will maintain a vacuum of 28·8in. (bar = 30in.) at full load of the turbine. The tubes have an external diameter of $\frac{3}{4}$in. and they are so arranged as to give as good a distribution of the steam as possible, so that all parts of the cooling surface shall be effective. The condensers were manufactured in Holland by Messrs. De Schelde, of Vlissingen, to drawings and specifications supplied by C. A. Parsons and Co., Ltd. The circulating pumps are in duplicate, each being driven by a separate motor and having a condensate pump coupled to it, and mounted on the same bedplate. Two air ejectors, each of which has sufficient capacity to serve the whole plant, so that the other is available as a stand-by, are provided. Each ejector comprises two steam jets working in series.

The steam from the primary jet is condensed in an intermediate surface condenser incorporated in the body of the apparatus, and the air entrained with the steam is cooled and largely freed from steam. The cooling water for this intermediate condenser is the main condensate of the turbine. The steam from the secondary nozzle is condensed in a similar surface condenser also incorporated in the body of the apparatus and using the main condensate as the cooling agent. Thus the whole of the latent heat of the steam used in the ejectors is recovered and employed usefully in heating the feed water.

(To be continued.)

Iron and Steel Institute.

No. I.

THE annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, London, on Thursday and Friday, May 5th and 6th. Sir Peter Rylands, the retiring President, was in the chair at the opening of the proceedings on May 5th.

The annual report of the Council for 1926, which had been circulated, was taken as read and was adopted without comment. Professor H. C. H. Carpenter, hon. treasurer, presented the accounts for last year. He pointed out that the deficit of £132 in 1925 had happily been reduced to £24 in 1926, despite the depressed state of the industry. He also referred with some pleasure to the check that had apparently been put upon the tendency of the membership during recent years to decline, or at any rate not to increase, inasmuch as during last year the amount received from entrance fees, which had been abnormally low in recent years, was higher in 1926 by £128 than in 1925. The accounts were adopted without discussion.

The new President, Mr. F. W. Harbord, was then introduced by Sir Peter Rylands, and on the motion of Sir Robert Hadfield a cordial vote of thanks was passed to Sir Peter for his services as President during

the past year. The next business was the presentation of the Bessemer medals. The President, after remarking that it was the usual practice to present only one Bessemer medal annually, said that, on a few exceptional occasions, when, in the opinion of the Council, two men working independently had in different ways equally contributed by their work to the progress of industry, two medals had been given. Such an occasion had arisen this year, and it was felt by the Council that full recognition of the great work of Swedish metallurgists could only adequately be expressed by conferring two medals, one on Mr. Axel Wahlberg, as representing the more practical side, and the other on Dr. Benedicks, as representing the scientific side of metallurgical research. Speaking of Mr. Wahlberg, the President said that he was Director of the Government Testing Institute at Stockholm in his early days and afterwards, whilst professor at the Royal University, was editor of the *Jernkontoret Annaler Journal*, one of the oldest technical journals in the world. As colleague of Dr. Brinell and afterwards his successor as general manager of the famous Fagersta Works, Mr. Wahlberg was associated with that famous metallurgist in much of his experimental work, and finally on Brinell's retirement from the position of chief technical adviser to the Jernkontoret, Mr. Wahlberg was selected to succeed him in that important position. From his earliest days Mr. Wahlberg was associated with all modern developments in the metallurgy of iron and steel in Sweden. By his sound knowledge and wide practical experience he had rendered the greatest service in the investigation and development of many new metallurgical processes, particularly in the smelting of iron ores in the electric furnace, and had taken an active part in the development of the Swedish iron ore resources. He had repeatedly represented his Government in negotiations with this and other countries, both during and since the war, when delicate questions of the highest importance of both a technical and industrial nature had to be dealt with, and by his ability, fairness, tact, and sound judgment he had won the respect and esteem of all.

Turning to Dr. Benedicks, the President said that he, as representing the scientific side of metallurgy, had earned a world-wide reputation by his researches into the constitution of metals and the physics of metallurgy. Whilst demonstrator of physical chemistry at Upsala University, Dr. Benedicks commenced, and afterwards as Professor of Physics at the University of Stockholm, continued to carry on his investigations, and since 1920, as Director of the Metallographic Institute of Stockholm, he had devoted all his energies to the study of the molecular changes induced in metals by heat treatment and generally to elucidate the many intricate problems connected with metallurgical physics.

Mr. Harbord then delivered his presidential address, an abstract of which was given in our last issue. Thereafter the reading and discussion of the technical papers was proceeded with, the first paper taken being "An Experimental Inquiry into the Interactions of Gases and Ore in the Blast-furnace," by Professor W. A. Bone, Dr. L. Reeve and Dr. H. E. Saunders. An abstract of this paper appears elsewhere in this issue.

Professor H. E. Armstrong, opening the discussion, said that he regarded the paper as the most important contribution on the subject since the days of Lowthian Bell. We required to get back some of the old attitude towards matters of the kind dealt with if we were to make progress. Unfortunately, at present there were not the men available to make the studies that were required; the schools were not providing them and therefore it was necessary to get a staff together and train it. He urged that the Institute should take up the whole subject, spending whatever money was necessary in order to get rid of the slur that rested upon us at present that we knew nothing about the fundamental chemistry of the iron and steel industry.

Mr. E. H. Lewis said that the investigation must at present be regarded as in the hands of the scientists, and the practical people would come in later. The question of hydrogen was interesting to him, and he would like to see the experiments in that connection carried further. In Scotland the gases in the furnaces were really a mixture of blast-furnace gas and coke oven gas because raw coal was used, and therefore it seemed that the investigation would have to be continued to deal with those and similar special conditions.

Mr. James Henderson remarked that although progress had been made in various directions in relation to steel manufacturing plant, the thermal efficiency of the blast-furnace was notoriously bad. He expressed the hope that the work would be pressed to a successful conclusion.

Mr. J. E. Fletcher spoke of the difficulty of finding out what was going on inside the blast-furnace, and he looked forward to learning a great deal more about the blast-furnace as the result of the researches being made by Professor Bone and his colleagues.

Professor C. H. Desch said that chemists would be bound to attach a great deal of importance to the suggestion that carbonyls were formed in the course of the blast-furnace reactions. Personally, he believed that it was practically impossible to bring about the decomposition of CO into carbon and CO_2 in a plain silica tube as used by the authors, but it happened readily in the presence of iron oxides. The action seemed very difficult to understand unless we assumed the formation of an intermediate substance like an iron carbonyl. Professor Bone's observations seemed to be of enormous importance in connection with the direct processes now being considered. The possibility of permeating the ore in a simple manner with very finely divided carbon, so that the next stage of the reduction was very much simplified, was a point to be borne in mind by all who were trying to develop direct processes.

Mr. D. Sillars, of Bolckow, Vaughan and Co., remarked that it was difficult to say whether, even if Professor Bone's suggested deposition of carbon in the lower region of the furnace were found to be a fact, it would benefit the operations in the blast-furnace unless we knew that there was some action taking place resulting in the reduction of CO directly to carbon. He imagined that even in direct reduction the first operation was the formation of CO in the lower region of the furnace. As to Dr. Desch's remarks, he did not think that the determination of the carbon deposition point would really be of much assistance in this country, although it would be an important factor connected with the use of Mesabi ores. The suggestion of the formation of carbonyls was by no means new, because he believed it would be found in an early edition of Professor Turner's book on "Iron," in which an analogy was drawn between Mond carbonyls and the possibility of some such reaction taking place in the blast-furnace.

Mr. C. H. Ridsdale said that the aim in investigations of the character described should be to get reduced coke consumption, and he could see nothing as yet, arising out of the paper, which pointed in that direction. That fact, however, did not in the least detract from the enormous value of the work being done. A point which had struck him was that if we could avoid too much carbon getting down in admixture with the ore, then it might be possible to obtain the lower carbon iron which foundrymen so much wanted to get plentifully and cheaply for high duty castings.

Mr. A. Hutchinson said that practical furnacemen wanted help from research workers which would lead to reduced coke consumption, and that could only come from a real understanding of what was going on in the blast-furnace. The first step must be to place the subject on a sound theoretical basis. Those engaged in practical work would come along later and say how far the fundamental work could be applied to the blast-furnace in practice.

Mr. E. C. Evans, National Federation of Iron and Steel Manufacturers, said that he had received a communication from the American Bureau of Mines as a contribution to the discussion on the paper. Referring to the work of Sir Lowthian Bell, it was pointed out that he set a ratio of CO to CO_2 of approximately 2·0, beyond which he said it was impossible to go when smelting Cleveland ore with Durham coke with a blast temperature of 500 deg. Cent. and a resultant top temperature of 300 deg. Cent. Bell also stated that it was impossible to improve the fuel economy by raising the blast temperature above 500 deg. Cent. Galey, however, with the dry blast, found a ratio of CO to CO_2 of 1·25 to 1·7, and Howland, on sixteen American furnaces, found a ratio below 1·7. Most modern furnaces in America, operating on Mesabi ores, were producing top gases containing ratios of CO/CO_2 less than 2·0 and were operating efficiently at blast temperatures higher than 500 deg. Cent. The Bureau had obtained data collected from one modern furnace showing a CO/CO_2 ratio of 1·15 to 1·6. Bell's limiting ratio had therefore been exceeded many times, and marked economy had been attained by raising the blast to a temperature above 500 deg. Cent. Bell's results probably applied to the particular conditions when Cleveland ore and Durham coke were used, but they did not apply to modern American blast-furnace practice with Mesabi ores and high blast temperatures. The American Bureau believed that under each set of operating conditions certain hearth temperatures were necessary for the maintenance of smooth and uniform operation and for the production of various grades of iron. Those conditions governed the fuel ratio required, and with a refractory ore as used for foundry iron the fuel ratio was automatically set at a higher point than with a less refractory ore. In modern practice the CO/CO_2 ratio in the top gas was largely determined by the fuel consumed per ton of iron, which in turn was adjusted to meet hearth temperature requirements. If higher top temperatures could be attained without changing the fuel consumption, the reducing power of the gases could be further utilised and lower ratios of CO/CO_2 attained. It was impossible, however, with existing furnaces to change top temperatures materially without changing the fuel consumption per ton of iron; in fact in good practice the top temperatures were low. Therefore, for all practical considerations, hearth temperature requirements, which fixed the fuel consumption, determined the ratio of CO/CO_2 in the top gas, assuming that secondary reactions such as carbon deposition and solution loss remained constant. The new data given in the paper on carbon deposition and its effect on reduction reactions, defining the temperature limits within which carbon deposition took place, were of practical interest to the Bureau, since it was believed that they would be of considerable value in interpreting results of certain surveys which the Bureau had completed, at various levels, in its experimental furnaces and in two industrial furnaces. The Bureau had measured actual gas velocities across the shaft of a 700-ton blast-furnace operating on Mesabi ores, the observations being made at a number of levels between the tuyeres and the stock line. The velocities were found to vary between the limits of 43ft. and 465ft. per second, indicating a time of exposure in a furnace, 68ft. between tuyere level and stock line, of the order of 0·15 to 1·5 seconds.

Professor Bone, replying to the discussion in general terms, expressed the hope that the necessary funds would be forthcoming which would enable his staff of workers on the investigation to be increased from two to four. He hoped to be able to go to higher temperatures and to deal with the difficult problem of relative velocity. The work described in the paper had occupied about two years, but the whole of the investigations that had been carried out were not described. At the present moment the funds provided amounted to £800 a year, of which £600 went in salaries and the remainder in expenses, but he did not believe it would "break" even an industry which had gone through the difficult times experienced by the iron and steel industry during the past year to double that amount. The next point was for someone to offer the use of a blast-furnace in which observations could be made, because much of the desired information could only be obtained in that way. It would be particularly useful to make such observations at a furnace plant where two or three different types of ore were being smelted. At the same time, he expressed the hope that patience would be extended to him; there were so many problems in connection with the blast-furnace that they could not all be solved at once. Many of them were not referred to in the paper, but they had not been forgotten, and he looked forward to the opportunity of discussing them with those engaged at the smelting centres, where an opportunity would be obtained of dealing with the problems *in camera* a little more freely, perhaps, than at a public meeting.

The only other paper taken before the morning adjournment was that by M. J. Seigle on "Some Aspects of the Technical and Economic Conditions of the Heavy Metallurgical Industry of France," which was read by the Secretary in the absence of the author. There was no discussion. An abstract of this paper is appended.

THE HEAVY METALLURGICAL INDUSTRY OF THE EAST OF FRANCE.

The "East of France" consists of two Departments, Meurthe-et-Moselle and Moselle. In the Department of Meurthe-et-Moselle there are three iron ore fields—namely, Longwy, Briey, and Nancy. In the Department of Moselle, returned to France as a result of the victory of 1918, the ore deposits and factories are to the west of the towns of Metz and Thionville—that is to say, to the west of the river Moselle. In the map the iron ore

deposits are indicated by single hatchings; the coal deposits of the Sarre basin, with a slight extension worked in Moselle, are marked by cross-hatching.

The metallurgical development of the region is based on the existence of an important iron formation, from 20 m. to 40 m. thick, comprising one or more workable beds. The beds slope from the hills, forming the western side of the valley of the Moselle, where the ore crops out. The outcrops are continued in the south of the Grand Duchy of Luxemburg, as well as in the region of Longwy. In the basin of Briey the ore is mined by means of shafts, 100 m. to 250 m. deep. The ore is phosphoric, and the interest in its development dates from the discovery of Thomas and Gilchrist in 1878, which gave birth to the process for the manufacture of steel known all the world over as the Thomas process. In certain cases the gangue is chiefly siliceous (Nancy and Longwy basins); in others, principally calcareous (Briey basin). Thus at many of the blast-furnaces the two types of ore can be mixed, so obviating the necessity for the addition of limestone.

With one exception, the factories in Moselle belonged to German companies; the last of these, built during the war at Hagondange by the Thyssen Company, is one of the best equipped. All the works originally German have been taken over by French companies, who have worked them since 1919.

During the war the Germans occupied a large part of the Department of Meurthe-et-Moselle, and, among others, all the iron ore mines in the Briey-Longwy basins. After the war an enormous amount of reconstructional work had to be accomplished, while all sorts of economic difficulties arose. Among others, the passive resistance offered by the Germans following on the occupation of the Ruhr in 1923, with the cessation of shipments of coke to France, may be remembered. The output of the large combined iron and steel works of Moselle has increased considerably the metallurgical productive capacity of France. Before the war an outlet for a fairly large proportion of the production had to be found by means of exportation. The necessity for exportation has now therefore become even more important for the metallurgical trade.

Before the war the coke consumed in Moselle, as well as a large proportion of that used in Meurthe-et-Moselle, came from the Ruhr; for the latter Department, the remainder came from the coal mines in the Department of Le Nord and Pas-de-Calais, as well as from the coke ovens in the north of France and in Holland, built by the metallurgical works in the Longwy basin. After the war, the coke problem became extremely difficult, for the Germans had destroyed the coal mines and coke ovens in the Department of Le Nord. The Sarre district is much nearer than the Ruhr, but the coals from the Sarre, being too rich in volatile matter, yield a friable coke which withstands badly transportation and handling, and is only suitable for small blast-furnaces; as a result, very little is used, except in the blast-furnaces of the Sarre. Attempts, attended by very interesting results, have been made to improve this coke, notably by mixing the fine coals of the Sarre district with lean coals from other parts or with partially distilled Sarre coal.

The coal comes from the Sarre, from Moselle and from the north of France. In proportion as technical improvements make more and more gas available for various heating purposes, so the consumption of coal in the iron and steel works is diminishing from year to year. It is an important fact that several combined iron and steel works in Meurthe-et-Moselle and in Moselle, which have thoroughly developed the use of their blast-furnace gas, no longer burn a single kilogramme of raw coal, except for the minute quantity necessary for their locomotives, and that without even possessing coke ovens. They must also on occasion allow certain quantities of gas to escape into the atmosphere. At some works, particularly those where the refining is carried to a high degree, the reheating furnaces are being adapted for heating by means of pulverised coal. In one of them the blast-furnace gas-fired boilers have been fitted with pulverised fuel burners connected with a central pulverising plant. In the event of a momentary insufficiency of blast-furnace gas, all that is necessary is to turn on the pulverised fuel burners.

During the war the shortage of blast-furnaces in France, due to the occupation of the metallurgical works of the north and east by the Germans, resulted in attempts being made to produce more pig per twenty-four hours in all those blast-furnaces remaining in French hands. After having put through the blast-furnaces all sorts of pieces of cast iron found in the stock yards of the works which could be spared, attention was directed to iron turnings derived from the turning of cast iron shells and to steel turnings and steel scrap. This latter material becomes carburised during its descent in contact with the coke, and it is actually cast iron which comes out of the furnace. The output of a furnace could be increased by 50 per cent. and more above that which would be obtained by charging iron ore only. Some furnaces ran on burdens consisting almost entirely of scrap, and one of them continues to do this, obtaining thus a non-phosphoric foundry pig, and even spiegel, using in this latter case a charge of manganese ore with the scrap. Apart from these extreme cases, the advantage of thus obtaining more pig iron per twenty-four hours from any given blast-furnace—the principal aim during the war—is connected with the further advantage that more pig iron is obtained per ton of coke consumed.

It would appear that, in British works, continuous current is in much more general use than three-phase, and that each factory produces only sufficient for its own needs. Continuous current is very convenient for driving rolling mills (facility of speed changes without the loss of energy), for driving roller beds (more rapid manipulation), and for driving various auxiliary plants. Three-phase current does not lend itself, without some artifice, to the alteration of the speeds of motors, or else much energy must be lost in the resistances which are inserted in the rotor circuits; but recent progress has surmounted the difficulties, and in the district dealt with in the paper there is a much greater use of three-phase current. The system of connecting the works to a single supply system has quite naturally become the general rule.

Before 1914 the iron mines of the Briey district, which were at some distance from the works, themselves produced the electricity of which they had need. For the service of the mines, some had steam engines, but others had installed electric motors on the Leonard system, the electric current being generated by steam engines. Three-phase current was very generally used. The reconstruction of the mines and works devastated by the Germans when leaving the occupied areas, naturally led to a great development in the use of electricity. The metallurgical works, iron mines and the supply systems of various independent regional companies interested in the production, transmission or distribution of electricity, had everything to gain by connecting up with each other, and these links extend as far as Switzerland. The existence of these connecting networks will, in turn, react upon the types of current and motor which the metallurgical works will need to install in the future.

The general tendency is to generate at the generating station only three-phase current, with gas engines or with steam turbines. A small part of this three-phase current is transformed for those uses for which continuous current is more convenient by means of converters installed in a sub-station close to the point where the continuous current is to be used. This permits of operation under the best conditions, such as small line losses and low expenses for cables.

The community of interests of works and mines has led a certain number of them to group themselves during recent years to form a company called "La Sidérurgie Lorraine." It possesses its own supply system, which is, or rather will be shortly, three-phase at 65,000 volts, 50 cycles. This company intends to use to the greatest advantage at all times the current available from each of its component works. Each producer has the right to a certain quantity according to the nominal power of its alternators—account being taken of the type of drive, whether gas engine or turbine—and its own needs.

"La Sidérurgie Lorraine" is aware at every moment of what power in kilowatts it can sell; it can thus decide for each works what average power the latter should provide for the supply system. In this way each works may be at one moment a producer, and at another a consumer, of electricity. For example, a combined iron and steel works might work its basic steel works and certain large rolling mills at full speed during only two periods of eight hours. It is thus a consumer of current above its average of production. On the contrary, during the third period the gases from the blast-furnaces continue to be utilised in full, and the generating station produces energy in excess of the requirements of the works, which is therefore sent out into the supply system.

On the other hand, a works with blast-furnaces only would be always a producer of an excess of energy. It would thus be assured of always selling it to the best advantage, owing to its connection with the supply system.

"La Sidérurgie Lorraine" is still in its early days. It expects to attain, in the course of two or three years, to a power of 100,000,000 kilowatts annually.

Two papers by Sir Robert Hadfield and one by Dr. W. Rosenhain and four of his colleagues were presented in the afternoon.

The first was "The Metal Manganese and Its Properties," by Sir Robert Hadfield, of which the following is a summary:—

MANGANESE AND ITS PROPERTIES.

In view of the importance of manganese to the steel industry, the author thought it desirable to give some account of the metal, also of its production in ferro-alloy forms. Whilst literature on the subject has appeared from time to time, it is in a somewhat disseminated form. The present paper endeavours therefore, to give a general historical account of the metal manganese and the uses to which it has been applied. Naturally, this is more specially concerned with its use in the steel industry—by far the largest industrial application—including the manufacture of modern alloy steels and also manganese steel of which it forms a considerable proportion. Another object of this paper is to show the interesting way in which the production and use of ferro-manganese was brought about, and the important part played in its development by our country. History shows the sequence to have been Heath in 1839, followed much later by Mushet, Prieger, Henderson, Bessemer, and, finally, by Mr. Pourcel. It is shown how the Henderson process was encouraged by Bessemer, then utilised in France, and resulted in the production of ferro-manganese of 60 to 80 per cent. in the blast-furnace by Mr. Pourcel, to whom in this respect our chief debt is due. In addition, there is given some account of the present world position as regards the resources of manganese ores, more particularly from the British point of view. The properties of the metal manganese itself—a matter of some importance if we are fully to understand its effects on steel—are also referred to so far as they have been ascertained. In this respect, our knowledge is still inadequate, though continued efforts are being made to remedy this deficiency.

The author concludes by hoping that the information given in his paper will provide a useful addition to the literature on the subject of manganese and its industrial uses. The old Chinese proverb says, "They who own the iron of the world rule the world." It would almost seem safe to add that they who own the manganese of the world have largely in their hands the control of steel of satisfactory quality such as is now necessary to meet modern requirements. Fortunately, Nature has spread the ores of manganese far and wide as they exist in the world—that is, they are not concentrated in one or two locations only, and cannot therefore be controlled by any one nation. The United States is now drawing large supplies of these ores from Russia, and is about to develop on a large scale newly acquired interests in Africa; Great Britain is developing her Imperial resources in India, the Gold Coast, and South Africa; France, Germany and Belgium derive their ores from a variety of sources. Singularly enough, no one country making steel on a large scale possesses the necessary supplies of manganese ore with which to make its steel. All are dependent on outside sources.

In introducing his paper Sir Robert said that so serious was the position becoming in America that it had been suggested that the United States Government should purchase in the open market over a period of nine years 600,000 tons of manganese and ferro-alloy ores suitable for making ferro-manganese in order to create a stock for use in case of a national emergency.

Sir Thomas H. Holland said that Sir Robert Hadfield had, in effect, raised two main questions that were now being considered for other minerals by the Institution of Petroleum Technologists and the Institution of Mining and Metallurgy. (1) Were we shaping our economic policy so as to secure in the future adequate supplies of manganese ores to maintain our steel industries? (2) What were we doing to secure supplies of these essential raw materials in the event of our ocean communications being interrupted during war-time? To answer both questions it was necessary to form a reliable picture of the present distribution within the Empire of accessible manganese ores of the right quality. Great Britain could not produce more than mere samples of manganese ore. We required every year, under normal peace conditions, some 150,000 tons of high-grade ore to provide the 50,000 to 60,000 tons of manganese metal now absorbed in steel smelting. We must have another 50,000 tons or so for essential chemical industries, and until recently we consumed about 250,000 tons in the manufacture of ferro-manganese for export. Those demands took no account of war conditions, when more manganese would be wanted, and when we might or might not be able to obtain supplies of steel from neutral countries within range of our base. Within the Empire our present two main sources were India and the Gold Coast, and perhaps either could produce enough to meet our requirements if necessary. South Africa was promising, but not yet certain. The journey from India, however, was long, and under possible war complications would incur serious risks. A portion of the same risks would be incurred by shipments from the Sinai peninsula. Was the Government taking steps to secure a sufficient share of the Gold Coast deposits as a war reserve? The Americans were reported to be taking an active interest in the deposits recently prospected in South Africa. If there were insufficient ore of the right sort still available on the West Coast, we ought to reserve a supplementary supply in South Africa as well. During wartime the Brazilian ore might or might not be available to us. He had spoken of war conditions purposely and deliberately, not because war was likely or unavoidable, but because it was the only circumstance that seemed to impress the public seriously. One could make out as good a case for the economic side, but economic issues were less pronounced, less sharp and less demonstrable. The consumption of manganese ore in America was about five times as great as in Great Britain, but it was possible to raise a certain amount of high-grade ore in the United States and to produce a large quantity of manganiferous iron ore—all of which would help to tide over a period of temporary shortage. The Americans were therefore in a safer position than we were, yet a committee appointed to study the subject had seriously recommended the building up of a war reserve of 600,000 tons of high-grade ore. It also pressed strongly for measures which would lead to economy in manganese, and urged the institution of systematic research on a considerable scale in the hope of finding substitutes that would render America less dependent on one particular form of raw material. The Council of the Iron and Steel Institute might ask itself whether it was safe to leave the question of manganese ore supplies to the normal trade developments, and, if not, what policy should be followed, first, to meet the changing economic situation, and, secondly, to prepare for possible military difficulties. If technical institutions confined their deliberations to purely technical problems, and left to Government all questions of policy we should find, as we did in 1914, that, when a national emergency arose, an embarrassing, possibly an unbridgeable gap might lie between the Government's requirements and the resources of the technical industries. There was one point of economic interest which Sir Robert had not dealt with. It might be put in the form of raw ore *versus* "ferro" as an article of export from the ore-producing areas. From the point of view of the ore-producing country, the export of raw ore was uneconomical. A high-grade manganese ore contained about 50 per cent. of the metal, and one-quarter of that quantity was lost in smelting "ferro." Every ton of Indian manganese consumed here therefore paid freight on some 3 tons of ore, and, as most of the Indian ore came from mines 600 to 700 miles from the coast, the freight at present rates was about two-thirds of the sale price at English ports. Some essential data had not yet been established, for example, the general suitability of Indian coke, much of which had inconveniently high proportions of phosphorus. Yet he was sure that some of the Indian coke was good enough, and "ferro" was made already for the requirements of the Tata Steel Works, to the extent of about 3000 tons a year, whilst a few small lots had been exported. There was enough manganese ore in India to meet far more than India's own wants for an indefinite future, and enough to cover the present annual export of over 600,000 tons for several generations at least. It was naturally far better to export the unwanted surplus, even if its full value were not obtained, than to leave it lying idle in the ground.

Colonel H. T. Levey, of the Gold Coast Colony Trade Bureau, who has recently returned from a tour of inspection of the manganese deposits of that country, both those that are being developed and those still to be developed, said that the former were being worked at full speed. The work had been rather hampered by lack of transport and harbour facilities, but the new harbour would be completed in a few months, and then it would be possible to ship 50 per cent. more manganese than at present. In 1926 the output had been increased over that of 1925, and the average now was from 1200 to 1400 tons per day. The natives of the Gold Coast took a peculiar interest in the manganese deposits, and whereas it was difficult as a rule to get labour there was a waiting list of about 1400 natives anxious to work in the manganese industry. Sir Arthur Kitson, the Director of the Geological Survey, had, during the past few years, discovered considerable deposits in the Gold Coast, but at present they were not economic propositions because of the distance from the ports. It was anticipated, however, that a new railway running some 350 miles north through Ashanti would be built in the near future, and then it would be quite possible to work these new deposits. The Americans had been endeavouring for a long time to obtain concessions in the Gold Coast, but up to now they had not succeeded in obtaining a single one of any kind. At the moment, the control was entirely British.

Mr. Herbert K. Scott disagreed with Sir Thomas Holland in speaking of the manganese problem from the point of view of possible war, because a good enough case could be made out for the kind of action that had been urged without war being brought into the question at all. Similarly, there was too great a tendency to assume that generations to come would not discover new deposits of minerals just as the generations that had gone before us had done. We could safely leave it to those who came after to develop the natural resources of the world, although they might do it in a different way from ours.

Sir Robert Hadfield, replying to the discussion, said that the Americans had large quantities of ore not suitable for producing rich ferro-manganese, but very useful for producing pig iron high in manganese and also useful for general steel purposes. There were something like 60 or 70 million tons of the material in sight. After urging the importance of developing the resources of the Empire, he said that he did not altogether agree with Mr. Scott that we should eliminate the prospect of wars. Perhaps if Mr. Scott had known the anxiety the makers of war material felt at the beginning of the war he would change his views on that matter. The Americans regarded the question of manganese as very important, because a whole symposium lasting for three days had been devoted to it at Cleveland recently, and if it were a matter of importance to the Americans it was necessarily of importance to us.

Sir Robert Hadfield's second paper, "Low Carbon

Alloys of Iron and Manganese," was then taken. An abstract is appended.

IRON AND MANGANESE ALLOYS OF LOW CARBON CONTENT.

In view of the fact that the manganese steel now used industrially contains considerable percentages of carbon varying from about 0·90 to 1·50 per cent., and that both carbon and manganese are instrumental in producing the remarkable qualities of this alloy, the importance of ascertaining definitely the properties conferred by manganese itself upon iron, that is, in the practical absence of carbon, has always been apparent. It was from this consideration that the author prepared various alloys of iron and manganese in order that comparison could be made between the qualities of materials representing two types of alloys of iron and manganese, the one with carbon varying from about 0·50 to 1·20 per cent., and the other with little or no carbon, 0·08 to 0·20 per cent. Some of these alloys, as regards their percentages of manganese, apart from their low carbon, would comprise products which might be considered to come under the term "manganese steel," though they must not be confused with the latter for industrial applications, for which there seems to be no particular field in the case of these low-carbon alloys. Nevertheless, it is important, from the scientific point of view, to have their various qualities—chemical, physical, and mechanical—put on record. The series of alloys comprised specimens showing the influence of manganese from 0·06 to 38·90 per cent., carbon not exceeding on the average 0·08 per cent.

In the general results of the research one of the features of outstanding importance is the literally marvellous influence of carbon. On consideration, it is not a little astonishing to find that the production of the material known as manganese steel, which the author discovered in 1882, would probably not have been possible had the ferro-manganese used in his researches contained a low percentage of carbon; 80 per cent. ferro-manganese ordinarily contains 6 to 7 per cent. carbon. The result of the present research clearly shows that alloys of manganese without carbon do not appear to be of commercial value. There may be applications here and there for some of the materials, but as far as at present ascertained, characteristics or qualities which indicate value from the industrial point of view have not been found. Ferro-manganese as ordinarily produced contains a ratio of about one-twelfth of carbon to manganese in 80 to 84 per cent. ferro-manganese. Consequently, in the manufacture of manganese steel there must always be about 1 to 1¼ per cent. of that element present in the steel produced, which is one of the chief reasons for its valuable properties. Take away that percentage of carbon and the product becomes of little or no value.

In high-speed steel and many other materials, an appreciable percentage of carbon is also absolutely essential to their character. Singularly enough, it has been found that certain other alloys of iron, if containing carbon in any quantity, say, about 0·50 per cent. and upwards, are not nearly so valuable as when the carbon is reduced to the lowest possible point, say, 0·10 per cent., and even under. The silicon steel which the author described in 1889 owes in part its valuable properties not only to the high percentages of silicon present, but also to the low percentage of carbon. The modern chromium steel alloys are much better in their resistance to corrosion in the absence, or presence only in low percentages, of carbon. This, too, also applies to the new types of nickel-chromium steel alloys. On the other hand, manganese-iron alloys with little or no carbon do not seem to offer any practical employment; they only become valuable in the presence of quite high percentages of carbon, 0·90 to 1·50 per cent.

Dr. Walter Rosenhain thought a word of warning was necessary. The alloys mentioned in the paper were not free from carbon, and Sir Robert might be going a little beyond his brief when he stated that the reduction of the carbon from 0·15 to ·01 would make very little difference. Recent experience of the effect of small traces of impurity, such as carbon would be in this case considered, indicated that a statement of that kind must have the fullest experimental verification. Without further investigation it would be very difficult indeed to offer any rational explanation of the rather complicated phenomena observed. The paper was, however, extremely interesting in showing that the carbon in manganese steel played such an important part.

Dr. W. H. Hatfield said that it would be interesting to know if Sir Robert had studied the composition of manganese steel from the standpoint of its wear-resisting properties, and, if so, whether he had found that when the carbon was low the wear resistance was affected. In connection with the previous paper on manganese resources, he remarked that if another war broke out and Sir Thomas Holland got a few of the steel makers together, they might be able to get through without using the excessive amount of manganese which some people thought was absolutely necessary.

Sir Robert Hadfield, dealing in his reply with the question of the effect of a low percentage of carbon, said that he hoped that the research would be a useful landmark for future work and comparison. He believed it would be possible to produce samples in which carbon was almost entirely absent, and he was inclined to think that there would not be very much difference in the physical properties, in spite of what Dr. Rosenhain had said. It could be said almost with certainty that low carbon material would not have a high resistance to wear.

The final paper on the first day of the meeting consisted of a batch of four reports on "The Alloys of Iron Research," by Dr. Rosenhain and four of his colleagues at the National Physical Laboratory. Abstracts of these reports are appended. Parts I., II., and III. of this research were presented in 1924, and Part IV. in 1926.

ALLOYS OF IRON RESEARCH.

Part V.: Preparation of Pure Chromium.—Chromium has been prepared by the electrolysis of an aqueous solution containing 30 per cent. pure chromic acid and 1 per cent. sulphuric acid. Deposits of chromium are readily obtained from the solution, using a lead anode, but it is frequently impossible to detach the deposited metal from the cathode. Three processes have been developed, all making use of lead anodes and solutions of chromic acid with small additions of sulphuric acid:—(1) Lead anode, porous cell, tin cathode; (2) lead anode, square steel bar cathodes; (3) lead anode, rotating steel tube cathode. The chromium prepared by the above processes differs greatly in form and to some extent in purity, but all samples as deposited contain both hydrogen and oxygen. The hydrogen appears to be liberated during the ordinary vacuum melting operations. The oxygen, which in the cathode chromium is present in a form which leaves no residue on solution in acid, changes its state on heating *in vacuo* and then produces insoluble oxide (Cr_2O_3). This oxide can best be removed by heating the solid cathode chromium in a stream of pure dry hydrogen at a high temperature—1500 deg. to 1600 deg. Cent. The great hardness of electro-deposited chromium is apparently caused by the hydrogen content, the crystalline form, and possibly oxygen, and it is not possessed by high-purity chromium which has either been melted or annealed at high temperatures. The melting point of chromium is considerably above that of iron, but an accurate determination has not been attempted owing to the difficulty of maintaining the purity of the metal during the process. Spectroscopic analysis failed to show the presence of any impurities in the electro-deposited metal.

Part VI.: Preparation of Pure Manganese.—Manganese of purity 99·3 per cent. has been prepared by the reduction of the oxide with aluminium, using the purest materials available. It has also been shown that Allmand and Campbell's method for preparing the metal electrolytically can be used for the production of moderate quantities of manganese. Manganese with total impurities less than 0·01 per cent. can, however, be prepared by the very simple process of distillation by means of the high-frequency induction furnace, the manganese distilling at a temperature just above its melting point under a pressure of 1 mm. to 2 mm. The metal thus obtained is silver grey in colour and very brittle. On melting down *in vacuo* an ingot is formed which is extensively cracked. The cracking is associated with one of the lower change points. The metal will scratch glass, and is at the same time very brittle. It does not tarnish when exposed to air. The melting point of manganese has been determined in an atmosphere of hydrogen, and four critical points have been found to occur below the melting point.

Part VII.: Preparation of High-purity Silicon.—It has been found that in commercial silicon, containing from 93 to 98 per cent. silicon, the impurities lie either in distinct strata or in the intercrystalline boundaries. When such material is attacked with acids, the impurities, consisting mainly of iron and aluminium silicates and of silicides of iron, calcium and magnesium, are dissolved, and evil-smelling and inflammable hydrides of silicon are evolved. If the best available commercial silicon is finely powdered and treated successively with *aqua regia*, hydrofluoric and sulphuric acids, and finally with hydrochloric acid, a product is obtained which in favourable circumstances contains 99·94 per cent. of silicon. Such material, after melting down in a silica crucible, exhibits a microstructure confirming the high purity of the product.

Part VIII.: The Constitution of Alloys of Iron and Phosphorus.—The research was undertaken with the object of determining the constitution of iron-phosphorus alloys, when materials of high purity and modern methods of study are employed. The work was commenced during the war by Dr. Hanson and the author. Considerable progress was made until pressure of important war work brought the investigation to a close. Since that time many advances have been made in the preparation of pure iron, and the use of the high-frequency furnace has greatly facilitated the preparation of iron alloys free from carbon. It was considered therefore that it would be worth while to start the investigation *ab initio*, and the results obtained are described in the paper. The iron used in the preparation of the alloys consisted of electrolytic iron prepared at the National Physical Laboratory by the methods described in earlier papers, the only appreciable impurity being about 0·015 per cent. phosphorus, which was obviously quite harmless for the research. The chemically pure red variety of phosphorus was employed. The alloys were prepared in a high-frequency induction furnace. It was found impossible, however, to get more than 30 per cent. of phosphorus into the iron. Alloys of about this composition on remelting evolved appreciable quantities of fumes of phosphorus. Alloys prepared in this way served as a basis for the preparation of material containing less phosphorus, some of the basis alloy being remelted with further quantities of pure iron. The prepared alloys showed on analysis a phosphorus content ranging from 0·089 to 30·0 per cent.

The results of the research are presented in the form of a constitutional diagram. They cannot be summarised in any useful way.

Mr. E. H. Saniter said that some attempt should have been made to get an estimation of the major portion of the chromium, manganese, and silicon in each case, although as a chemist he knew the difficulty of determining something which was nearly 100 per cent. of the body.

Dr. W. H. Hatfield complimented the N.P.L. and the authors on another contribution of a fundamental character and of the highest importance. It was to be hoped that the whole field of the binary, ternary and other systems would be covered in a similar manner.

Mr. McNaughton, Woolwich Research Department, said that at Woolwich they had obtained chromium which was harder than the hardest mentioned in the paper and softer than the softest. One of the great factors in that respect was temperature. It was difficult to offer a satisfactory explanation with regard to the effect of oxide in the chromium. It might be a factor which was of great importance in the hardness of chromium deposits, or it might be a nuisance, as in his own case. The general opinion at present was that those somewhat complex oxides, which were formed by reduction at the cathode surface, were disseminated through the bar in a colloidal form and might serve to restrict the growth of crystals by forming an inside film in the process of deposition.

Professor C. H. Desch, said that now that the high-frequency furnace was a regular laboratory appliance, it was possible to make much more use of the distillation method for the preparation of manganese. It had been found that iron and nickel could be distilled quite readily in a high-frequency furnace when a really high vacuum, say, $^1/_{1000}$th mm., was maintained. That was a good way of preparing sheets of thin metal foil.

There were no verbal replies to the discussion.

ANNUAL DINNER.

On the evening of Thursday, May 5th, the Institute held its annual dinner at the Connaught Rooms, London. About 280 members and guests assembled for the occasion, with Mr. Harbord in the chair. The toast of "The Iron and Steel Industries" was proposed by Mr. H. B. Betterton, Parliamentary Secretary to the Ministry of Labour, and was responded to by Sir W. Peter Rylands. "The Guests," proposed by Mr. John Craig, was replied to by Baron E. K. Palmstierna, Swedish Minister Plenipotentiary. Mr. John Hodge, in a characteristically witty manner, proposed "The Iron and Steel Institute," to which the President, Mr. Harbord, responded.

(To be continued).

Suction Gas for Commercial Vehicles.

No. II. *(Conclusion).**

THE drawbacks to the use of suction gas for motor vehicles are mainly:—(*a*) The weight of the producer, which adds a quarter of a ton or more to the non-paying load; (*b*) the low efficiency of the petrol engine running on suction gas; and (*c*) the necessity of laying up the vehicle from time to time for a general cleaning and overhaul. These are serious objections which it is sought to overcome by simplifying the plant. One of the reasons for the use of charcoal is that it may permit of the suppression of the scrubber, or at least to reduce its dimensions considerably. If it were not for the heavy dead load of the plant, it would be possible to use wood very economically, and that has been done for a long while past by Berliet, who has been demonstrating the reliability of the wood suction gas plant by running vehicles many thousands of miles all over France. The owner of a Berliet lorry declares that his daily cost of fuel is 18 francs for about 38 miles. It has run for five months without being overhauled. This seems to indicate that colonial users, who are unable to procure cheap liquid fuels, can very well run lorries on wood, but it implies also that the vehicle must be in expert hands, for it is inevitable that the tar products of wood will necessitate keeping the plant in good condition and overhauling the engine occasionally. Wherever charcoal can be obtained at a reasonable cost the use of wood is likely to be restricted, and the object of providing cheap charcoal of good quality is to extend its application to all classes of commercial vehicles.

One of the difficulties attendant upon the use of suction gas is the condition laid down by the Ministry of War that suction gas subsidy vehicles must run either on petrol or on suction gas, petrol being used generally for quick starting and for running with overload. On the other hand, the Government remits one half of the taxation on all vehicles running on suction gas, on condition that no provision is made for the use of petrol. If suction gas is to become a recognised fuel for all kinds of commercial vehicles, the engines must be designed to run on the gas, or some such device must be adopted as that suggested by Monsieur Malbay of fitting the engine with two combustion chambers, one for petrol and the other for suction gas, so that the latter may be used in greater volume and with a higher compression. To compensate for the increased dead load and provide ample power, the compression must range from 6 kilos. to 7 kilos., and it is possible even to get up to 10 kilos., but such compressions necessitate reliable and efficient self-starters. On account of the heavier weight of the vehicle, the suction gas engine should develop rather more power than the petrol engine for a given paying load. That is only possible with engines of larger cylinder capacity and running at lower speeds. The suction gas engine is an internal combustion engine, and the gas is used under unfavourable conditions in an explosion petrol engine. Makers will not design and build special engines for suction gas unless they are assured of a demand for them, and there can be no certain large demand until users are sure of procuring ample supplies of cheap charcoal.

During the present transition period, therefore, the application of suction gas to the motor lorry is a matter of compromise. The whole problem at the moment lies in running existing engines with suction gas at high compressions and in reducing the weight of the suction gas plant to a minimum. Much has already been done in this direction, to the extent that, after hanging fire for a considerable time, charcoal is being used more extensively in cases in which everything is subservient to low running cost. It is not yet certain what that cost actually is, for, while an economy of 70 to 80 per cent. in fuel cost, as compared with petrol, is claimed—taking petrol prices no doubt at their recent high figures in France—there is little reliable data concerning capital charges and upkeep of suction gas plants.

Eleven firms ran suction gas vehicles between the Halle aux Grains at Blois, where an exhibition was held, and the Forest of Menars, where the demonstration of carbonising apparatus was in progress. The short journeys on a level road did not impose any special load on the engines, but all the vehicles ran satisfactorily, and, in fact, the running of a number of such cars around France, with scarcely any incident, implies that the suction gas vehicle is reliable in competent hands. It is affirmed that suction gas would be more popular on account of its economy if it did not meet with opposition from drivers who object to the extra trouble of looking after the suction gas plant, and it is proposed to enlist their sympathies by interesting them in the economies realised by the use of this fuel. In all the plants the object is to reduce

* No. I. appeared May 6th.

the space occupied by the apparatus to a minimum.

In the "Autogaz" plant—Fig. 4—the generator is placed under the chassis with the hopper at the side of the driver. There are air inlets in the double cover of the generator, and the air is drawn into the space thus provided, down through a small vertical water chamber attached to the generator, and back through the incandescent charcoal. The gases then pass down outside the water chamber into a small scrubber of oval section divided into three chambers. The gases pass up through water in the lower part of the scrubber and then into a compartment above filled with granulated cork. Thence they descend into the bottom of the third compartment containing a small quantity of oil and paraffin to remove any acid, and the scrubbing is completed by the gases passing up through the end of the chamber containing bronze spirals, to remove the oil, and then into the carburetter. This plant was fitted to a Delahaye lorry in which the engine bore had been enlarged and the compression increased to 6·1 kilos. No petrol was used for starting. It was affirmed that the engine could be started up within five minutes of lighting the charcoal. In any case, it appears that the charcoal becomes incandescent so quickly with the fan blower that very little time is lost.

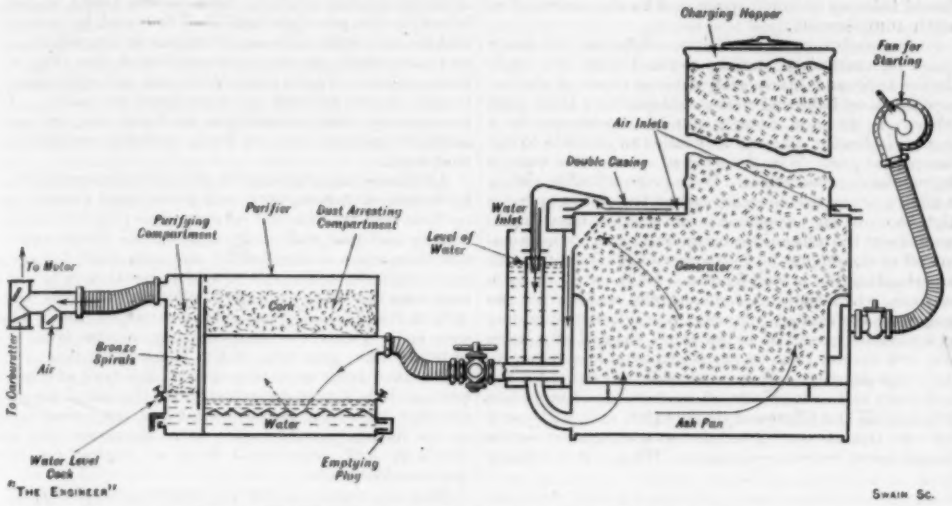


FIG. 4—ARRANGEMENT OF THE "AUTOGAZ" SUCTION GAS PLANT

Some of the generating plants shown in the Halle aux Grains at Blois were reduced to a simplicity that offered little guarantee of their being able to produce a pure and clean gas, unless the claims are borne out by actual results. On the other hand, the "Malbay" suction gas plant does not aim at the suppression of necessary operations. They are grouped in a way to reduce space as much as possible, and while employed largely for industrial purposes, the plant is successfully adapted to heavy commercial vehicles and even to marine applications. As showing the economy of the system it is affirmed that a Fordson tractor conveyed a load of 4½ tons from Paris to Bordeaux at a speed of nearly 7½ miles an hour with a consumption of 258f. worth of charcoal. In the Malbay system—Fig. 5—the combustion chamber A, which is lined with fire-bricks, has an annular water chamber B and is surmounted by the hopper C in which sufficient charcoal is carried to permit of the vehicle running a considerable distance. Below the combustion chamber is a circular grate D that can be rotated by the hand wheel E. The water level in the annular space is maintained by the tube and funnel F. Steam from the water chamber is drawn into the tube G, where it mixes with warm air arriving by the pipe H from the cooler J. The mixture is adjusted by the valves K and L. The gases now pass into the baffle chamber M, where the dust is deposited on the baffle plates, which can be drawn from the cylinder for rapid cleaning. Then passing up through the tube N the gases enter the cooler J, which is composed of a large number of tubes through which air is drawn by the ejector O connected up with the engine exhaust pipe. Descending to the bottom of the scrubber P, the gases traverse the water Q into the filtering column and thence to the engine. The Malbay plant is employed on tractors and on the heavier types of vehicles.

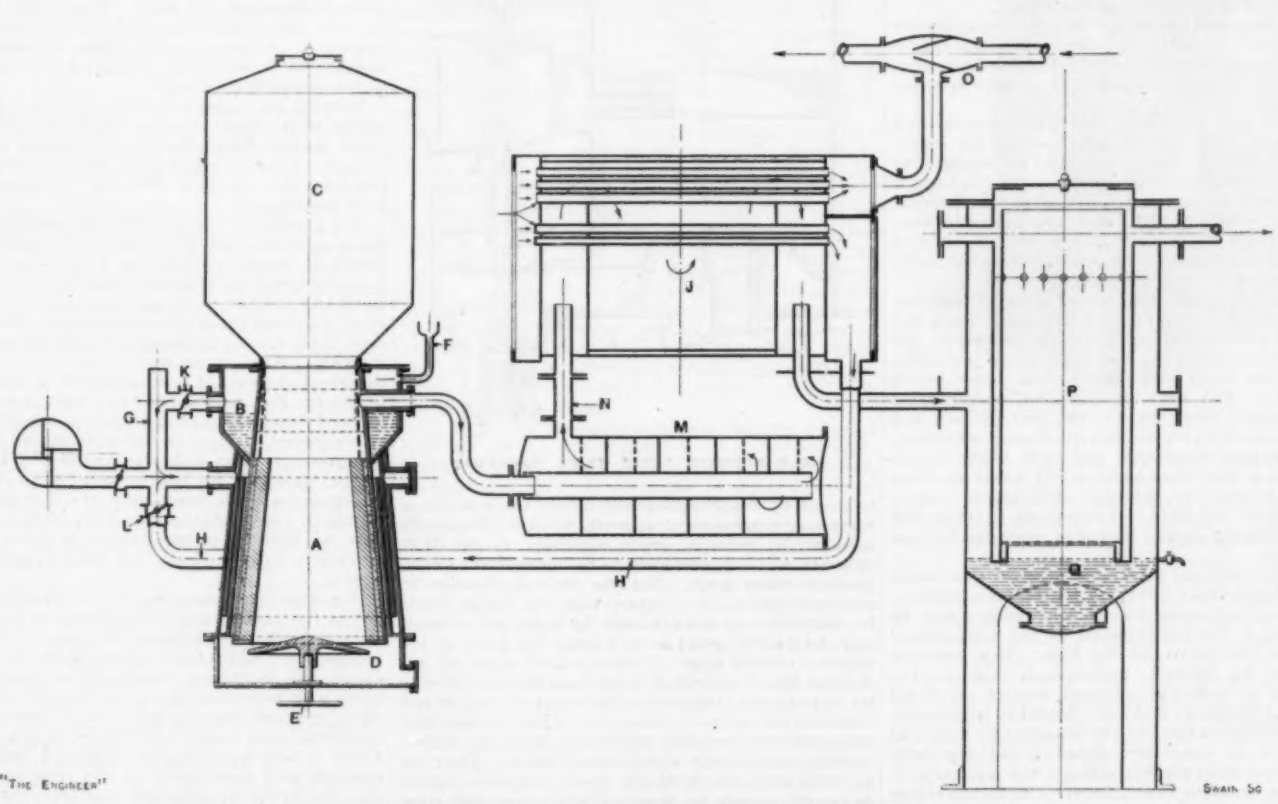


FIG. 5—ARRANGEMENT OF THE MALBAY SUCTION GAS PLANT

The motor car firms running lorries on suction gas were Renault, Panhard and Levassor, and Berliet, and several other vehicles were in service equipped by makers of suction gas plants. A road roller belonging to the Municipality of Blois was running on suction gas, and apparently it has proved quite satisfactory, while the economy of fuel consumption in a centre of charcoal production was remarkable. A Baldwin petrol locomotive was running on suction gas on a short track in the Forest of Menars, and a Fordson tractor with a similar equipment was busy ploughing in an adjoining field. All kinds of vehicles demonstrated the use of suction gas, from vans to huge lorries hauling several tons of timber. The general impression was that the lighter lorries experienced no trouble of any kind, but where the engines were constantly developing their full power the speed was lower than when running on petrol and, in the case of a huge timber wagon, the long pipe conveying the gas to the engine, and made purposely long for cooling, was very hot. In some of the lorries the gases pass through a tubular cooler placed transversely underneath the chassis, where the refrigerating effect should be sufficient to keep the temperature down.

The congress held during the demonstration dealt with the charcoal suction gas problem mainly from a national standpoint, particularly with regard to the available wood resources, but an address of general interest was made by Monsieur Coupan, professor at the Ecole de Grignan, who remarked that suction gas could not be substituted for petrol on pleasure cars. For commercial vehicles it was far nearer realisation than petrol was at the beginning of the motor car movement, that is to say, it had far fewer difficulties to overcome. With charcoal there was no necessity to use a mass of fuel, for experience had shown that the producer continued to give gas when the layer of charcoal had fallen to as low as 2in. The difference between the calorific value of suction gas and town gas was not so great as was generally represented, suction gas giving 6000 calories per cubic metre as against 8000 calories. He thought that with high compressions in a suitable engine it would be possible to get as much power out of a kilogramme of charcoal as from a litre of petrol.

Apart from wood and charcoal, alike in its natural and compressed forms, some prominence was given to peat by Monsieur Charles Roux, who claims that he is able to produce a granulated peat by a somewhat complicated and expensive installation. A large experimental plant is now being laid down, and the result of its working will be watched with interest.

The charcoal suction gas vehicle is of so much value in Africa that it has been decided to organise a big trial next autumn, when the vehicles will run all through North Africa from Tunis and down to Casablanca.

THE INSTITUTION OF CIVIL ENGINEERS: AWARDS.—The Council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1926-27:—Telford Gold Medals to Mr. I. J. Jones, M. Inst. C.E. (London), and Mr. T. B. Hunter, M. Inst. C.E. (London); a Watt Gold Medal to Mr. Gerald Curry, M. Inst. C.E. (London); and a George Stephenson Gold Medal to Mr. A. L. Bell, M. Inst. C.E. (Malta); Telford Premiums to Mr. A. W. Stonebridge, M. Inst. C.E. (Bombay); Mr. P. R. Roberts (Barrow-in Furness); Mr. A. C. Anderson, M. Inst. C.E. (London), and Mr. George Ellson, M. Inst. C.E. (London); a Manby Premium to Professor Douglas Hay, M.C., M. Inst. C.E. (Sheffield); and a Trevithick Premium to Mr. Powys Davies, Assoc. M. Inst. C.E. (India).

The Modern Steam Engine and Internal Combustion Motors.

By MAURICE DEMOULIN.

No. V. (*Conclusion*).*

NOTWITHSTANDING what has been said above, the use of highly superheated steam may involve, for reciprocating engines, important modifications, its application to ordinary types of engines, being, if we go to the bottom of the question, what I dare to call a compromise, an incomplete and provisional solution, except for engines working consecutively for a few hours, as it is the case with locomotives. In fact, steam converted into a gas is no longer subject to the action of the walls of the cylinders, a drawback which triple and quadruple-expansion engines are intended to remedy. They are used therefore to allow a great ratio of expansion, combined with long periods of admission and the use of ordinary slide valves which might become, in this case, on the contrary, a source of difficulty when superheating is carried far.

These engines develop the same power, for the same piston speed, as a single-cylinder engine, of which the only cylinder has the same volume as the L.P. cylinder of the first engine and the expansion being the same. The multiple expansion engine loses, with superheated steam, its principal advantage, keeping only some superiority in reducing leakage past the pistons and piston valves, the difference of pressure being smaller between one of the cylinders and the other. But they have their drawbacks, too, which can be outlined as follows :—

(1) Steam from the boiler is admitted to the H.P. cylinder only, and, in consequence, special valves must be provided for starting or reversing. They are a real complication and are the source of some delay in manœuvring.

(2) Their bulk, complication and weight must be justified by important advantages which, as we have seen, are much lessened.

(3) The area of cylinders and valve boxes (notably for L.P. cylinders) exposed to cooling by radiation or convection is increased.

(4) The cost of maintenance is increased.

It must be noted, however, that with four cylinders and the cranks set at the necessary angles, the engine can be approximately balanced. But this balancing can be obtained more completely by simpler arrangements.

Now, and this is an important fact, superheated steam, when pushed far enough, modifies the *régime* of the steam engine in such a manner as singularly to reduce the advantage of separate expansions, since it converts the fluid into a gas not subject to internal condensations in the high and even intermediate-pressure cylinder. We are here in the presence of two devices of the same order, which it does not really seem necessary to employ conjointly.

It might be objected that the adoption of turbines, whilst allowing a long ratio of expansion when the vacuum is sufficient, eliminates those drawbacks, but the reciprocating engine has kept many partisans, especially for cargo boats and powers under 10,000 horse-power. For ships of the kind, reciprocating engines, when slow (85 to 100 revolutions) and strongly built, have remarkable qualities of reliability, robustness and flexibility, and will work almost indefinitely in conditions which would defeat the other types, especially the internal combustion motor. It is not to be backward and retrograde to think that the reciprocating engine, improved, may yet hold its position.

One is thus brought to conceive that—the pressures not being higher than 220 lb. to 250 lb., for example—a return to compounding with two cylinders may be considered, if the temperature of the superheated steam is at least up to 670 deg. Fah. This assertion must not be deemed paradoxical, but as the expression of practical progress resting on sound scientific principles and of desirable simplicity. But this condition can only be obtained by a radical modification of some arrangements and especially of the valve gear in the very rational way inaugurated, I think, by Monsieur Lentz, Caprotti and some others in a manner which takes different forms and is already applied on merchant ships of several countries.

The valve gears to be adopted for such engines must eliminate the drawbacks of ordinary slide valve gears designed for long periods of admission with saturated steam, without presenting complications, and must in addition be devoid of parts subjected to friction to allow the use of very highly superheated steam. In a word, these valve gears must be, in some respect, though much more simple, similar to those adopted for motors, with this considerable difference, that they are to be controlled by ordinary links so as to allow for manœuvring and reversing as easily and quickly as with ordinary marine engines.

These new valve gears should include separate valves and ports for admission and exhaust in order to avoid one of the principal causes of internal condensation and be quite independent of each other, so that the variation of percentage of admission will not have any effect on the other phases of distribution, such as exhaust, compression, &c. They ought particularly to be of limited dimensions and offer small clearance volumes. They would do away with the enormous L.P. and even I.P. piston valve and steam chests of powerful triple-expansion engines, when the piston speed is not very low, and avoid also difficulties in the casting of large and complicated cylinders. As a matter of fact, a L.P. cylinder with two piston valves is exceedingly bulky, and it seems really irrational that the parts only used for steam distribution should take up so much space and be the source of so much complication.

Such conditions as these have obtained for many years on stationary engines derived from the early Corliss type and fitted with various types of sliding, oscillating or balanced valves independent from each other. I do not attach much importance to a regular indicator diagram as similar as possible to the theoretical one. Wire-drawing of steam, to a certain degree, has no bad effect. With ordinary slide valves it allows us, on the contrary, when the piston speed is high, to obtain expansions far greater than could result from the admission corresponding to the nominal cut-off of the engine, and it causes a slight spontaneous superheating, as is well known. In the case of locomotives, when running, for example, at 50 miles per hour with the reversing lever at a notch corresponding to a nominal cut-off of 40 per cent., the real admission may not exceed 15 to 20 per cent., even less, owing to this wire-drawing. However, slide valves have the well-known disadvantage of a close interconnection between all the phases of distribution and, with early cut-offs, the advance of admission and exhaust or the compression become excessive. Hence, if we desire

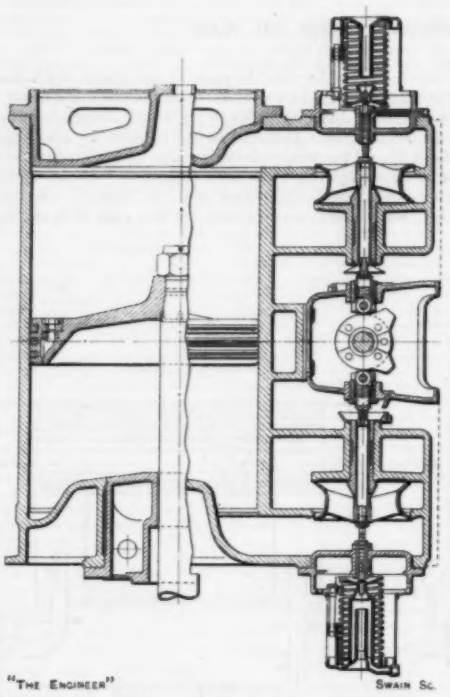


FIG. 4—MODIFIED LENTZ VALVE MECHANISM

to profit by superheating and reduce the number of successive expansions in separate cylinders, the cut-offs have to be reduced, more especially in the H.P. cylinder, and it is necessary to have recourse to independent valve gears. But, for their application to marine engines, it is necessary that the valves should be controlled, as already said, by links and without any detachable gear; in one word, by gears of the positive motion type. Poppet valves, more or less derived from the Cornish type, balanced and offering no more friction than the valves used on motors and therefore not subject to seizing or injury at very high temperatures, are really the proper types for engines working with highly superheated steam. Their use allowing early cut-offs at any speed, a sufficient degree of expansion may be obtained with two-crank compound engines. Thus if the ratio of cylinders L.P./H.P. = 4 volumes, a cut-off $\alpha = 25$ per cent. in the H.P. cylinder will correspond to a nominal expansion of 16 volumes; if $\alpha = 18$ per cent., the total expansion will reach the high figure of 22·2 volumes—more than can be obtained with triple-expansion engines using ordinary valve gears, and it is not useful to go as far as that. This is not in contradiction with what has been said above concerning wire-drawing and slide valves, as, in the present case, the early cut-offs have no pernicious effect on the other phases of steam distribution. It may be objected that the coefficient of irregularity will be greater than it is with actual triple-expansion engines, but it will not be so in a proportion great enough to minimise the simplification, and the arrangement described a little further on will reduce this inconvenience to nil.

It will be possible to set the cranks of the two cylinders, H.P. and L.P., at 180 deg., as in the internal combustion motor, thus securing a sufficiently approximate balancing of the reciprocating parts. Starting, however, will not be possible at all positions of the cranks. To remedy this state of things it will only be necessary to couple, on the same bed-plate and crank shaft, a second engine, identical with the first, but of which the cranks are set at 90 deg. to the first.

We have thus constituted a compact four-crank engine of neat design, including no bulky cylinders, valves, and steam chests, nor any complicated mechanism, as easily started and reversed as the ordinary marine engine. Such is the Lentz engine, of which the principle has been followed by several makers and, with some modifications or simplification, and particularly by an important French firm (Fig. 4). It can employ, thanks to its valve gear, as highly superheated steam as may be considered advisable. It has already been adopted, as we have said, by progressive engineers, and its use is probably predestined to spread.

Admission and exhaust for each cylinder are effected by balanced valves, very well guided and pressed on to their seat by external springs, thus preserved from pitting and rust and easily examined. These valves are themselves controlled by one cam shaft for each set of cylinders, the rods of which are always in contact with the cams through a roller, in the usual way, so that there is no impact when the valves close. The cam shaft receives a reciprocating motion from an ordinary link, generally of the Hackworth type.

We have dwelt at some length on this type of engine because it is a new departure from the usual marine practice of a very rational kind and may constitute in the future, possibly after some improvements, an excellent and economical type of engine for the mercantile marine.

Such an engine, as far as consumption of steam is concerned, should compete closely with the turbine, whilst it offers, for moderate powers at least, the advantages of reciprocating engines and does not need any reducing gear. But the adjustment, erection and maintenance of the cam shaft needs precision and care. It is the only weak point, and on it must be directed the ingenuity of makers and inventors, so that this type of valve gear may have the same robustness as the ordinary slide valve gears. It shows, at all events, in what direction it is necessary to proceed to compete with success from all points on board ships with the internal combustion motor when turbines are not used. It is rather surprising to note that there is actually a tendency after a century to return to valve gears similar in many respects to those of the Cornish type and anterior to the classic Watt's engine.

It must be understood that the author does not adhere to the above type of engine in particular, as other makers may produce even neater and better designs; it is only given as an example with no other intention than to show what may be considered as a good method.

The question of the type of boiler and of automatic firing is settled for large plants on land, and the design of electric stations the world over is more or less established, as it has been recalled in these articles. In this application there is no question of the employment of another prime mover than steam, when we consider the flexibility of these plants and their economical working. When using water-tube boilers furnishing superheated steam at a temperature of from 650 deg. to 750 deg. Fah., with air and feed heaters and possibly induced draught, and the propelling machinery being either geared turbines or turbo-generators for electric transmission, there seems no reason why the marine engine, especially for high-powered ships, should not be operated with practically no divergence from standard power station practice, save perhaps in that oil burning is convenient in many cases, as automatic stokers do not yet seem in favour for sea service.

For cargo boats and passenger steamers of moderate power the author earnestly believes in the future of water-tube boilers designed for long sea voyages, or boilers of the mixed type similar to the one described above, the propelling machinery consisting of turbines with reduction gear, or of poppet valve reciprocating engines more or less derived from the Lentz type and using highly superheated steam, of course. There is here open, for the maker, a large field of research and application, as the time has come to give up all routine and break away from the old track.

In what concerns the locomotive engine, economy is less sought after than the obtaining of a maximum power per unit of weight or wheel base. Moreover, this engine is subjected to conditions of service and special limitations which have never permitted it to deviate from the classic design of its principal parts. All attempts to adopt other types of boiler or motion have failed, and it is likely that they will suffer the same fate for a long while to come. Here steam, and applied in the same way as now, can have no other rival in the future than electric traction, at least for certain branches of service and in special circumstances. The application to the locomotive of water-tube boilers, turbines or Diesel motors and electric transmission, will always remain as solitary attempts without practical results; their general use is not even to be dreamed of. In fact, the locomotive of to-day differs only by its power and weight from the engines running on the first railways, so well was the problem solved from the beginning. The only real and effective improvement it has received in what concerns the efficiency of steam, or rather of increasing

* No. IV. appeared May 6th.

its power per unit of weight, has resulted from the application of superheated steam, the economy of which has reached 18 to 20 per cent. Indeed it is probable that superheating was first adopted on a large scale on locomotives and to such a degree that since 1910 there has been scarcely one main line engine built not fitted with superheaters. In the beginning there existed some doubt concerning the efficacy of internal lubrication and some apprehension of possible pitting and corrosions in the cylinders, more especially as they are horizontal. Experience has proved that none of these fears was well founded, thanks to piston valves, tail rods to the pistons, and the use of special oils; besides, in locomotives, the temperature of superheating seldom exceeds 525 deg. Fah. and never reaches more than 660 deg., even when the engine is exerting all its power and with the maximum draught. With a view to limiting this temperature the rear ends of the tubes of the superheaters are situated at a carefully calculated distance from the fire-box tube plate.

Now, it is well known that the locomotive engine, working with superheated steam, is economical in fuel for a non-condensing engine. It burns often less than 3 lb. of coal per I.H.P. Electric traction may have many advantages for suburban lines or special services, but as regards fuel consumption an economy can only be obtained if the total efficiency, from the boiler in the electric station to the rim of the electric locomotive wheel, including all efficiencies, from the grate of the boilers, mechanical or electric, is not less than about 35 per cent. in the best conditions.

Conclusions and Recapitulation.

From what has been said in these articles, it results that for important land plants, and particularly central stations, steam, thanks to many improvements, may be considered as used almost exclusively, and does not seem likely to meet with any competitor. Many stations are in successful operation which produce 1 kilowatt at the switchboard for 1 lb. of coal. They have a great flexibility and meet widely varying conditions of capacity and load. The question of the steam engine, as a prime mover, for this application, is no longer open to discussion. Successive improvements, the invention of satisfactory types of water-tube boilers, with their many accessories, and the use of superheated steam up to 750 deg. and turbo-generators, have made of these stations probably the most interesting and successful creations of modern engineering.

The steam locomotive, with all its known qualities of endurance, simplicity, flexibility in all kinds of service on rails, will have for some services no other rival than electric traction, the prime mover being yet steam, save in countries where water power can be developed.

The question of propelling machinery at sea is more complex, for reasons of which several have been discussed above. Probably, if we except warships, liners, and the most important passenger steamers, a part of the success of the internal combustion motor is the result of a kind of "stand-still" in the designing of marine engines, and of some want of research, though it must be acknowledged that some interesting exceptions have presented themselves and more progress has been obvious in recent years. What difference is to be seen between the triple-expansion machinery of the modern cargo boat and the engine of thirty years ago! We have a good, serviceable and strong engine, it is true, but the lack of invention is evident. The same boiler, same accessories, same machinery except some details not of the first importance. One would think that the engine of the end of last century had reached finality, and that the last word in marine engine design for commercial ships had been said. Has the coal consumption been sensibly reduced? Has the weight or bulk been lessened? It is not a failure though. Far from it; since this engine has qualities of its own. But what does not improve goes back, and the internal combustion motor, pushed by progressive promoters, has made its way. It can be safely said, I believe, that the success of Diesel motors at sea is for a great part the result of a lack of improvement of the common marine engine.

The criticism presented in this article concerning the engines and boilers of ordinary or second-rate ships must not be interpreted as bearing on the principle of steam engines, but on applications that are not always up to date, and that often do not tell of initiative or progress. I sincerely believe that in many cases where the motor has gained the advantage, the steam engine could have answered as well, perhaps better even in the long run, if the necessary steps had been taken.

Upon the whole a vessel, passenger or cargo, fitted with water-tube boilers of a type appropriate to the service to be performed, with superheated steam at a minimum temperature of 680 deg. Fah., air and feed heaters, and, if possible, oil burning, the propelling machinery consisting of high-speed turbines with double gear reduction—or reciprocating engines of an improved type, such as the Lentz class for moderate powers, 4000 H.P. to 8000 H.P.—if we account for all expenses, all conditions of service, reliability for very long sea voyages, easy repairs in almost any important harbour, would give most satisfactory results, and would compare in every way with motors. A large liner, using 50,000 H.P., can be operated with a daily consumption of 340 tons of fuel oil, cheaper than the Diesel's, perhaps less, or 450 to 600 tons of coal. Actually, for such a steamer and in the above conditions, including everything on board, the consumption should not exceed 0·85 lb. to 1 lb. of good coal per H.P. hour.

Of course, the remarkable records and the success of internal combustion motors which have even surpassed the expectations of their most sanguine promoters cannot be lost sight of. Diesel engines for ship propulsion have arrived at a high degree of improvement, and it is quite out of the question to lessen their value. I simply insist on this fact that the steam marine engine may be improved, and that it can stand comparison with motors, having, indeed, advantages in many cases. The world-wide publicity given to motors, and the enthusiasm they have excited in many circles have contributed as much as their own merits to their success. It is yet to be proved that they represent the last word for the present in mechanical progress, and it is to be expected that their expansion may have for result such an increase in the cost of special oils as to give in the future a serious advantage to the coal or cheap oil burning steam engine. These questions must be studied rigorously and in complete independence of mind. Only industrial and commercial considerations must be admitted, and all must be duly weighted.

The makers of marine engines must, as has been stated and repeated above, remember that the times have changed, that the steam engine has now a serious competitor at sea, and they must leave the usual tracks and endeavour to obtain, as far as possible, results similar to those obtained in large electric power stations where steam is exclusively used, nobody dreaming of adopting other prime movers than those actually in use.

The following figures which have been recently given speak for themselves. If we do not take into account the momentary rise in price, due to strikes and speculations, which cannot last indefinitely, it is possible to admit that normally the costs of different fuels are as follows in the Far East:—

Ton of good coal	.. ..	$p = 1·0$
" fuel oil for boilers	.. ..	$p' = 1·5$
" Diesel oil	.. ..	$p'' = 1·8$

If we allow for the sinking fund corresponding to the higher cost of motors, even after the deduction of economies produced by the reduction of *personnel* and of stokers, it has been calculated that the difference between the total cost of working of coal-fired steam engine and motors will be nil, when p and p'', instead of being in the proportion of 1 to 1·8, reach the ratio of 1 to 2. Even if it be considered that the above figures are open to discussion, they show at all events, if the fuel consumption alone is not considered, how small is the margin left.

Facts of this kind begin to be recognised, and we should not be surprised if a reaction, more or less important, takes place, especially by reason of the great trustworthiness of the steam engine. Already we see that the Hamburg-America Line thought it advisable to order—one of them is delivered—after inquiries and discussion relating to the system of propulsive machinery, four 14,800 tons and 13,000 H.P. ships, using boilers and turbines with reduction gears—and this in the land of the Diesel motor. It is no doubt an indication.

There is another important consideration which I have not yet mentioned in favour of steam and coal-fired boilers, especially when rendered more economical, for passenger and cargo steamers. From the national point of view, for countries like Great Britain and Western Europe, which must purchase oil from foreign countries or colonies, coal firing is clearly desirable. In case of conflict or war, the stocks of oil might be extremely reduced by blockade, and in any case would be requisitioned for warships. Would not the merchant vessels, at least fitted with internal combustion motors, run the risk of remaining useless, while the coal-fired ships would not lack fuel? It would be imprudent to neglect such casual circumstances. Power stations have avoided such an eventuality by sticking to coal.

The preceding review shows, I hope, that whatever be the vogue of internal combustion motors for sea-going ships, the steam engine is yet susceptible of improvements and is far from having arrived at the limits of its evolution. Its qualities of robustness, of reliability, of regular working in the hardest conditions, on the longest sea voyages, its easy manœuvring, will perhaps be more appreciated than they are now. There is room for the motor ship and the steamer, which are certainly destined to co-exist for a long time to come, according as circumstances bring out their respective merits.

In any case, steam still offers the best solution, we should say the only one, for very high-powered ships and for high-speed vessels. The results obtained on land plants show that it can be used very economically when the necessary steps are taken.

The Cape Town Electricity Undertaking is proposing to expend half a million on extensions. Of this amount 80 per cent. is required for developing the transmission and distribution systems, while the remaining 20 per cent. is for a new 7500-kilowatt turbo-generator, two boilers and auxiliary machinery.

Paint-making Machinery.

No. V. *(Conclusion).**

The machines which we have already described cover the majority of requirements of the average paint maker, but there is a variety of other forms still in use, some of which are going out of fashion, while others are only applicable in special circumstances. There are two to which reference must be made. They are the disc mill and the ball mill.

The disc mill is mostly favoured for the grinding of coach colours and similar purposes, as it produces a very fine result; but, by comparison with roller mills, its output is small, and it is, consequently, only suitable for making comparatively small quantities of costly paints or enamels. The old-fashioned disc mills closely resembled the ordinary grit-stone mill, and some of them were fitted with stones, while others had metal discs, but they all suffered from the disadvantage that the discs tended to wear into concentric grooves, which, acting like a labyrinth packing, gradually prevented the free passage of the paint between the grinding faces until they were re-dressed. This trouble has been overcome in the mill shown in Fig. 21, which is made by Torrance and Sons, by giving the running disc a compound movement The disc is mounted on the top of a vertical spindle, and is driven by bevel gearing, as shown in the illustration. At the same time it is given another excentric movement at a comparatively slow speed by means of the worm gear below. The result is a gyratory form of

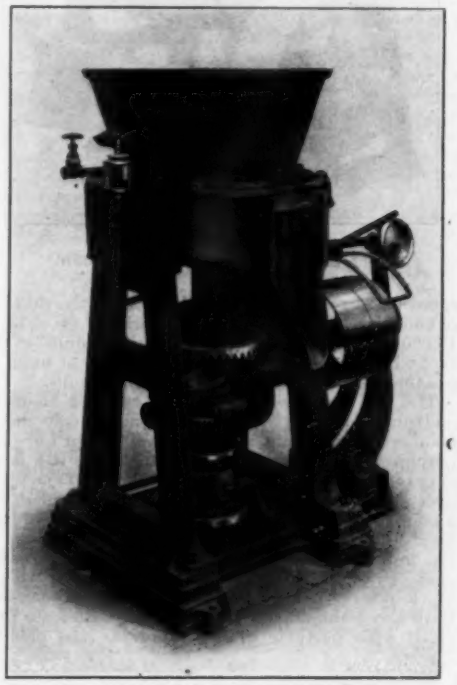


FIG. 21—GYRATOR DISC MILL—TORRANCE

movement which insures that the grinding faces will always wear perfectly flat and cannot get grooved. The upper grinding member is not really a disc at all, but is a ring fixed beneath the lower edge of the hopper, so that the bottom of the hopper is formed by the lower grinding disc, and the only outlet for the paint is by way of the extremely fine clearance between the grinding faces. Both the disc and the ring are gashed with grooves, running at opposite angles, which extend nearly to the periphery, but there is a plain surface, a quarter of an inch or so wide round the outside where the actual grinding of the paint takes place. The gashes serve to feed the paint in between the grinding faces, and this action is facilitated by a stirrer fixed to the running disc and extending up the centre of the hopper. The ground paint slowly oozes out from between the two discs, and is scraped off by a little plate bearing lightly against the edge. It then flows directly down a shoot into any convenient receptacle. The ring grinding member is so arranged that it can be water-cooled if necessary and the grinding clearance is adjustable by means of the micrometer hand wheel, which can be seen in the base of the machine. It is necessary to slack off only three bolts to release the hopper, and both grinding members, when the whole of the parts in contact with the paint are accessible for cleaning.

There is yet one other process of paint making and that is by means of the ball mill. The method has the advantages that only one machine is required, and it does not require much skilled attention. A mill of this type, made by Hind and Lund, Ltd., of Preston, is illustrated by Fig. 22. The principle of the ball mill, in which the charge is ground by being rolled around inside a drum in company with a number of

* No. IV. appeared April 29th.

metallic balls or pebbles is, of course, well known; but it may not be so generally understood to what an extent the balls do actually rub and grind the charge, so the following calculation may be of interest. Taking, for example, a mill 4ft. 6in. in internal diameter, the distance through which the balls will drop or slide will be 36in. The number of times a ball or pebble will drop during each revolution of the cylinder is difficult to estimate. If they had a free drop it would be almost twice during each revolution, but the drop is interrupted, and it may be assumed that 1·6 times the number of revolutions will be near the actual number of drops or slides for each ball or pebble.

If contacts are made 2½in. apart, each ball or pebble will make 14·4 contacts underneath and 14·4 sidewise, hence a total of 28·8 contacts for each drop, or $28·8 \times 1·6 = 46$ contacts for each ball or pebble during each revolution of the cylinder. Taking the

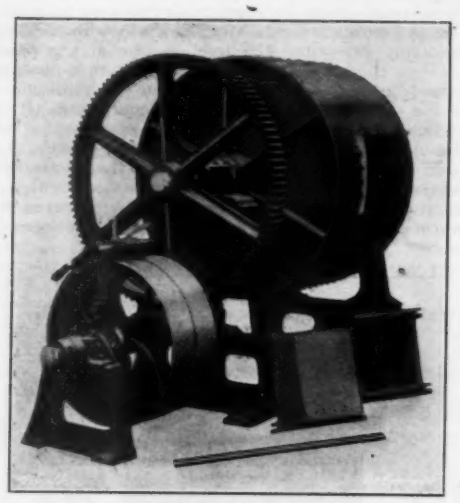


FIG. 22—BALL MILL—HIND AND LUND

speed at 23 revolutions per minute, and the number of balls or pebbles at 16,000, there will be $46 \times 23 \times 16{,}000 = 16{,}928{,}000$ contacts for every minute of the run, which, as every contact gives a blow of more or less force, explains the efficiency of these mills.

The mill itself is a strong steel cylinder mounted on trunnions and driven by gearing in any convenient manner. It is generally lined with silex, but for some purposes a steel lining is adopted. There is a large door for charging purposes, and in the case of machines over 42in. in diameter this door is large enough for a man to enter the cylinder. The door is, of course, lined to make it flush on the inside with the rest of the lining. Opposite the door there is another smaller opening, which can be plugged up or fitted with a quick-opening valve for discharging the contents. Both the manhole and the discharge outlet are provided with portable grids to prevent the pebbles

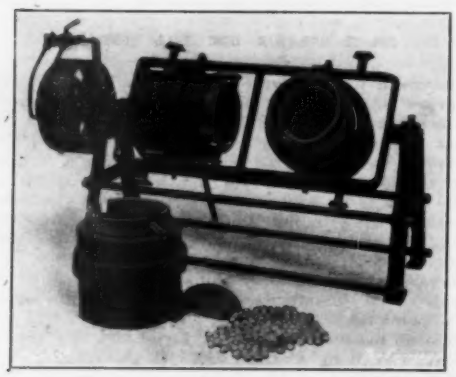


FIG. 23—LABORATORY BALL MILL—HIND AND LUND

falling out when the outlets are opened. In the end of the drum there is a cock, through which samples can be taken during the course of a run, or a compressed air connection can be made to force the charge out and deliver it to an upper floor. In the case of a machine 4ft. 6in. in diameter the length of the cylinder is generally from 3ft. to 5ft., and it will run at about 25 revolutions per minute. Taking the longer size, it will have a capacity of 210 gallons of ready mixed paint, and requires a charge of about a ton of pebbles. At starting up the machine will require about 7½ horse-power, but it will run with 5 horse-power when well under way. A mill 6ft. in diameter by 8ft. long requires 22 horse-power, and will accommodate over 600 gallons of paint.

In operation, the amount of pigment and vehicle required to make a charge are dumped into the mill from a floor above, and the manhole door is replaced. The machine is set in motion, and from time to time samples are taken from the end cock to see how the grinding is progressing. When the charge is finished it may either be discharged in the pasty form, or it may be thinned down to make ready-mixed paint in the mill itself. It is only necessary to add the thinner and give another run of five or six minutes to make a thorough mixture for discharge.

It might be thought that it would be a difficult job to clean such a mill when changing from one colour to another, but, as a matter of fact, it is quite easy. The paint is well drained out, and one or two successive small charges of thinning are run through the mill. These cleaning charges can, of course, be put by for the next batch of the same colour.

The time necessary to finish a charge naturally depends on several factors, but it amounts to from 1 to 1½ hours for the cheaper grades of paint, up to 36 hours for coach paints, and as much as 50 hours for bone black in lacquer.

The little mill shown in Fig. 23 is intended for small batches or laboratory work, and is very useful in determining the proportions necessary in starting to grind an unfamiliar paint. Each of its jars will hold about 26 lb. of material.

In concluding this short series of articles on paint making machinery, it seems appropriate to give a few recipes, taken from the catalogue of Hind and Lund, for the proportioning of various colours of paint. These proportions are given for the making of semi-paste colours in linseed oil :—

Colours.	Per cent. Pigment.	Per cent. Oil.	Volume in Gallons per 100 lb. semi-paste.
Basic carbonate white lead	80	20	3·48
Basic sulphite white lead	78	22	3·75
Zinc oxide	70	30	4·6
Lithopone	70	30	5·1
Lamp black	20	80	10·11
Carbon black	20	80	10·10
Drop black	35	65	8·6
Venetian red	70	30	5·7
Indian red	70	30	4·85
Para red	20	80	10·35
Ochre	60	40	6·65
Raw sienna	40	60	8·02
Burnt sienna	40	60	8·02
Raw umber	40	60	8·02
Burnt umber	40	60	8·02
Metallic brown	67	33	5·8
Ultramarine blue	45	55	8·2
Prussian blue	30	70	9·6
Chrome green	65	35	5·52
Chrome yellow	70	30	4·6
Red lead	85	15	2·71
Graphite	35	65	9·00

When inert substances are to be ground with any of the above pigments, the proportion of pigment to oil must be changed to take into consideration the difference between the bulk value and oil absorption of paint pigment and that of the original pigment.

Some Recent Services of Metallurgy to Engineering.*

By Professor H. C. H. CARPENTER, Ph.D., F.R.S.

(*Concluded from page* 491.)

POSSIBLE USES OF PEARLITIC CAST IRON.

AMONG the possible uses of pearlitic cast iron may be mentioned :—

(1) Parts of steam and internal combustion engines. On account of its excellent strength properties and absence of strains, it can be cast lighter, thus saving both material and weight, especially in locomotives, marine engines, &c., where the question of weight is important.

(2) Its high resistance to abrasion indicates the use of the material where mechanical parts are subject to sliding friction, *i.e.*, pistons, piston rings, cylinders, crossheads, gear wheels, &c.

(3) Steel and malleable castings are often distorted and deformed owing to the heat treatment which they must necessarily undergo. Pearlitic cast iron maintains its original form as it is not subsequently heat treated. Many parts which are now made from steel and malleable castings could with advantage be made from the new material in cases where the strength properties—*e.g.*, expansion—of steel and malleable iron castings are not brought into play.

(4) It has long been known that high silicon cast iron tends to grow—expand permanently—when subjected to high working temperatures, such as those which prevail in internal combustion engines. Up to about 1 per cent. of silicon the casting is suitable in this respect. Beyond this content there is a great tendency for growth to occur. Hence the advantage of pearlitic cast iron with its low silicon content for motor parts.

The evidence indicates that the production of the pearlitic graphite structure in cast iron represents a great step forward in the foundry industry.

SORBITIC STEEL.

Steel wire ropes, after passing through the "patenting process," which consists in heating to a temperature at which the steel scales, and then cooling more or less rapidly through the critical points, contain large quantities of "sorbite" readily detected by the microscope after etching, or by the dark colour that the whole surface assumes when etched side by side with the rod before patenting. The property of enabling the patented rod to be drawn to a much greater fineness than is possible in the unpatented material is due to the effect of the sorbite present. Stead and Richards concluded that if sorbite is responsible for the excellent qualities of oil-quenched steel and negatively quenched steel wire rods, there is no reason why it should not be produced in steel rails, tires, &c., without great expense. With this object in view, they experimented on 5ft. lengths, subjecting them to a variety of treatment.

Their work showed that the maximum quantity of sorbite could only be obtained by rapid cooling to below the critical points, followed by tempering. They showed photographs indicating the difference between sorbitic and ordinary steel. The microstructure of the sorbitic and pearlitic portions shows a most marked difference. The latter is a heterogeneous mixture of ferrite and pearlite, while the sorbitic portion appears almost homogeneous. When the metal was suddenly cooled the carbon or carbides were diffused in solid solution, did not segregate into the normal carbide areas and were retained in solid solution, but on tempering, owing to the rigidity of the mass at comparatively low temperatures, although the carbides must necessarily fall out of solid solutions more or less completely, they remain in what we have previously compared to a nascent state of separation. The result is that the carbides in the iron are left in a most intimate state of admixture and the structure of the steel is very homogeneous. They carried out relative wear tests on untreated and treated rails, and taking the wear of the former at 100, that of the latter varied between 33 and 80.

Although the results of these experiments were decidedly promising, Stead and Richards were not able satisfactorily to treat a normal 30ft. length of rail. In all their experiments the distortion of the longer lengths was so considerable that their process never became a commercial success. The practical problem of treating the full lengths satisfactorily was solved by Messrs. Sandberg, so as to produce sorbitic structure. This process complies with the four following points :—

(1) The improvement does not reduce the existing output of rolling mills.

(2) No scrapping of existing plant or erection of elaborate new plant is required.

(3) The improvement does not increase unduly the cost of the finished rails.

(4) It increases both the safety and the durability of the rails.

The process for hardening steel rails and tires by compressed air, steam or moistened air, invented and patented by Messrs. Sandberg, has been found to meet these conditions. They realised that the right temper in the rail could be obtained in the course of one single operation if the correct rate of cooling through the critical range of temperature was secured. The precise range depends upon the composition of the steel. Their experiments using air cooling were so encouraging that they were soon able to treat full-length rails of heavy section. The results obtained made it perfectly clear also that their process could be carried out without interfering in any way with the output of the rail mills and at a comparatively low expenditure. The first rails treated were tramway rails, and gaugings taken from these after they had been one year in the track under very severe traffic showed that their life would be about 100 per cent. longer than that of the Sandberg high-silicon rails of the same composition, but untreated and laid at the same time in the same track. Plants for the Sandberg treatment of rails were put down by the Bethlehem Steel Company at their Sparrow Point Works, where trials were carried out and excellent results obtained. Shortly afterwards another plant was put down at the Dowlais Works of Guest, Keen and Nettlefold, while a number of trial orders have been carried out on rails for various home railways. The plant is situated at the delivery side of the rail mill, and consists of a series of air pipes connected to a compressed air receiver. The rail going through the hot saw at a temperature of about 900 deg. Cent. is brought under the horizontal air delivery pipes. In this latter a series of ports is cut from which the compressed air escapes on to the rail head. It is delivered at a pressure of about 15 lb. per square inch.

The plant for the air toughening of tires, works on the same principle. The tire is revolved slowly during the process, and the air delivery pipes are so jointed that tires of any size can be treated.

In the United Kingdom sorbitic rails have been placed on trial by various railways, but sufficient time has not yet elapsed to obtain much reliable information. However, on the Metropolitan District Railway sorbitic steel rails showed a superiority of 80 to 90 per cent. over ordinary steel rails as regards loss in weight. On very sharp curves it has been found that, on electric railways rails have to be scrapped owing to undulatory wear, not on account of loss in weight. For this reason the advantage of 80 to 90 per cent. of sorbitic steel over ordinary rails referred to was reduced to 40 per cent. Upon British tramways, owing to their greater resistance to battering and to detrusion, sorbitic rails have met with decided approval, about 35,000 tons having been

* The thirty-third James Forrest Lecture delivered at the Institution of Civil Engineers, May 3rd, 1927.—Condensed.

supplied to various systems, and, in consequence, several of the largest tramway undertakings in the United Kingdom have adopted these rails as their standard.

ALUMINIUM.

My reference to this metal can only be of the briefest. Adequate treatment would require, not merely one, but several lectures. It is the first light metal to enter the ranks of the commercial metals. Its specific gravity is about 2·73, and it has therefore only about one-third of the specific weight of the commercial metals—iron, copper, zinc, lead and tin—which have been known and used for so long a time. Once obtained in the form of pig metal by the modern reduction process—the electrolysis of purified bauxite—it can be cast, worked, alloyed and manufactured with moderate ease. The metal and its light alloys have been the source of much general public interest in recent years, owing largely to their utilisation in domestic use, aircraft construction—aeroplanes and airships—and the automobile industry. The art of flying has been built up on the use of aluminium alloys and, in particular, of duralumin. Metallurgically, it is one of the most interesting of the metals, and so much scientific investigation has been devoted to it and its alloys that the technique of its manufacture is efficient.

The aluminium industry of the world has grown by leaps and bounds since the metal became relatively cheap commercially, and this growth appears likely to continue. Its applications are destined to increase to a large extent, and the only present deterrents to its much greater employment are the question of price and the possible exhaustion of the bauxite supplies. Its merits and those of its light alloys have been forced upon the engineering trades against a not inconsiderable opposition, and their actual worth for use as engineering materials of construction has been proved beyond any doubt. About 50 per cent. of the production of aluminium is used as such in the manufacture of sheets, wire, rods, &c. The remaining 50 per cent. is principally employed in the manufacture of light alloys. The annual production of the metal now exceeds 200,000 tons.

The most remarkable fact about aluminium is that it exists at all. It is a very highly oxidisable metal, and its reaction with oxygen is one of the most strongly exothermic actions known ($Al_2 + 3O = Al_2O_3$). Practical use is made of this fact in the employment of thermit, a finely divided mixture of aluminium and ferric-oxide, which is used in the welding of steel rails, &c., where the heat of oxidation of the aluminium at the expense of the ferric-oxide is sufficient to melt the iron and raise the temperature to over 2000 deg. Cent. ($Fe_2O_3 + Al_2 = Al_2O_3 + 2\,Fe$). How comes it, then, that aluminium can not merely exist as a metal, but be used for the great variety of purposes for which it is employed at the present time? The answer is that when cast in ingot form the compact metal is rapidly covered with a thin film of oxide (Al_2O_3), which is sufficiently strong to protect the underlying metal from further oxidation. It is, however, not merely a question of strength, but also of structure, and the structure of the oxide is such that it prevents the diffusion of oxygen from the air to the underlying metal. This film also serves to protect the metal during fabrication, and even if it is destroyed in places, a fresh film forms on the exposed parts. The film in question is very thin and almost transparent. Its existence was shown some years ago by Dr. Seligman and Mr. Williams.

HIGH-SPEED TOOL STEELS.

The revolutionary feature wherein tools made of high-speed steels differ and exceed in service the tools formerly used, is their ability to maintain a sharp, strong cutting edge while heated to a temperature far above that which would at once destroy the cutting ability of a simple steel tool. A high-speed tool can be made to cut continuously at speeds from three to five times as great as that practicable with other tools and, when as the result of the friction of the chip on the tool it may be red hot at the point on top where the chip rubs hardest, and the chip itself may, by its friction on the tool and the internal work done on it by upsetting it, be heated to a blue heat of about 300 deg. Cent. or even hotter. Accordingly these tools have in the past twenty years worked a remarkable revolution in the machine shop business of the whole world, affording largely increased outputs and commensurate lower costs. As a consequence, they are now being used very generally, and in some shops almost exclusively, for machining iron and steel as well as some other metals by cutting operations by machine tools.

The property of red hardness, or ability to retain hardness at a red heat, may be imparted to steels of suitable composition containing chromium, tungsten and vanadium, and, in the most recent tools, cobalt as well, by a unique heat treatment to which they are subjected. This is the Taylor-White process introduced at the works of the Bethlehem Steel Company in 1899. Tools thus treated were shown at the Paris Exhibition in 1900.

In the early days, after a good deal of experiment, the composition settled down to a basic one of about 14 per cent. of tungsten with 3 to 4 per cent. of chromium. The next step was to introduce still greater percentages of tungsten and also to add vanadium. A class of steel has now been on the market for some time containing about 18 per cent. of tungsten, 4 per cent. of chromium, and anything up to 2 per cent. of vanadium. This class appears to have justified itself as indicated by the wide demand for it. The next development came comparatively recently with the addition of cobalt (from 2 to 6 per cent.). These steels have also taken their place and found a market. In some steels molybdenum is added as well as the above four alloy elements.

All such steels are made by the crucible or electric furnace process. The pots hold 90 lb. to 100 lb. The melting of the charge takes about four hours. After melting, the charge is "killed" in the usual way by being held thirty to forty minutes. Such procedure regularly gives sound piping steel. The ingots range from 3¼in. by 3¼in. to 5in. by 5in. in cross-section and from 9in. to 16in. in length. As cast the steel has a coarse structure and dark colour. A corner is broken from the top of each ingot to show the grain, and the ingots, when hand-poured directly from the pots, are classified by the eye as in the production of simple steels. As a rule, ingots show a strong columnar structure of crystals whose axes are normal to the cooling surface. Some makers refer to this as a "lemon" structure, the crystals of the steel being thought to resemble the cells forming the pulp of a lemon. The ingot is then heated and worked so as, as far as possible, to destroy the primary structure. This is done by re-heating it to about 1200 deg. Cent. and working it down under the hammer or press.

The heat treatment given these steels for common use as lathe and planer tools has generally been simplified to a heating to incipient fusion followed by quenching in oil. Cooling by an air blast and the double treatment which were formerly recommended are now not common, except that a second heating is given to milling cutters and similar tools, the temperature imparted to the bath depending upon the material to be cut. Heating may be done either in a blacksmith's forge fire or, better still, in a bath of mixed salts. The latter is better, as it preserves the composition of the tool, and unless this is done quenching results are apt to be irregular. The quenching temperature is usually about 1260 deg. Cent. Quenching is done in oil. In some shops, however, the original treatment recommended by Taylor and White is given, the cutting edge of the tool being heated to incipient fusion and then immersed in a bath of melted lead at about 565 deg. Cent. After this it is taken out and placed in an air blast to complete the cooling. Some tools required to be especially tough, so as not to break in service, are given a second heating to 565 deg. Cent.

The cutting edge of a rapid tool at work is probably never as hot as the metal which is behind it, where the heating caused by the friction of the chip as it is deflected and rubs hard on the tool is most intense. The edge itself is kept relatively cool by the cold metal flowing upon it. It is not generally realised that the point of the tool does not cut, and that it only drives open the crack which advances in front of it. A high-speed tool fails through the turning which impinges on the top face of the tool, wearing away the steel until the cutting edge is actually broken off.

NICKEL-CHROMIUM STEELS.

Nickel-chromium steels, known in the trade as chrome-nickel steels, are perhaps the most important of all the structural alloy steels Their field of usefulness is continually being enlarged by their application for new purposes and also by encroachment on the fields of some of the other alloy steels, notably of simple nickel steel, and they have almost wholly displaced nickel-vanadium and nickel-chromium-vanadium steels, which several years ago were in some considerable demand.

They are seldom used in any but a heat-treated condition. By suitable treatment pieces of small mass can be made to have as high physical properties as any steels known, with any elastic limit between 18 and 110 tons per square inch, accompanied by ductility that is high as compared with its strength, since the ductility naturally lessens as the elastic limit increases. They can be made somewhat more cheaply than simple nickel steels of the same strength and ductility containing a smaller total of the alloying elements, and chromium is less costly than nickel. The upper limit of nickel in useful chrome-nickel steels is about 3·5 per cent., and all useful steels of this class are pearlitic.

Most of the nickel-chromium steel goes into armour plate, projectiles and automobile parts.

MUMETAL.

The first commercial application of high-frequency melting in Europe was made by a British firm for the preparation of nickel-iron alloys for submarine cables. The research work pursued in order to find a suitable alloy was thereby much facilitated, and quickly resulted in the perfection of the series of alloys known under the name of "Mumetal"—so called because the Greek letter μ is the symbol of permeability. These alloys have highly desirable characteristics, and by their use the speed of cabling can be increased seven to eight-fold.

A typical mumetal alloy has the following composition:—

	Per Cent.
Nickel	74·0
Iron	20·0
Copper	5·3
Manganese	0·7

An alloy of this composition has a magnetic permeability of 7000. Low hysteresis loss with a very high permeability at low magnetising forces are the characteristics chiefly required in these metals.

The composition of the mumetal may be varied according to the type of cable which it is proposed to use, and the annealing may be adjusted to give either (*a*) maximum neutral permeability, (*b*) maximum permeability at magnetic saturation, or (*c*) high or low fields for magnetic saturation.

The range of alloys developed for this class of work contain from 75 to about 50 per cent. of nickel, with percentages of iron varying from 20 to 25, and certain quantities of copper and manganese, but in every case freedom from carbon is one of the primary essentials, and for this reason the high-frequency furnace has proved the only suitable melting equipment.

In certain types of cable an increase in electrical resistance of the alloys is desirable, and in this case an extra element, which may be tungsten, chromium, silicon, vanadium, titanium, molybdenum, or aluminium, may be added in small quantities.

STAINLESS STEEL.

The so-called "stainless steel" was first introduced in 1914 in the form of table cutlery, and its almost exclusive use for cutlery purposes for some time after that date has led to the belief that "stainless steel" is simply a special type of cutlery steel with a very limited range of mechanical properties. In reality, however, stainless steel is really "a whole series of steels whose mechanical and physical properties vary widely in a manner similar to the variations met with in the different varieties or tempers of ordinary carbon steels, all of which have the distinguishing property of great resistance to corrosion conferred upon them primarily by the presence of a suitable percentage of chromium." As a general rule, the amount of this element present varies from 11 to 14 per cent.

The original discovery was made by Mr. Harry Brearley in 1913, at that time chief of the research laboratory maintained by John Brown and Co., Ltd., and Thomas Firth and Co., Ltd., of Sheffield. The story is told by Mr. Monypenny in the following words:—"He [Brearley] was at the time engaged on an extensive research on the resistance to erosion of various steels in reference to their use for rifles and naval guns. Among the steels examined for this purpose were some containing large amounts of chromium. In the course of these investigations numbers of samples in different conditions of heat treatment were examined microscopically, as is, of course, usual in such investigations. In carrying out this examination Mr. Brearley noticed that these high chromium steels were either not etched at all or only attacked very slowly by the usual reagents used for etching the polished surfaces of sections of steels prepared for microscopic examination, and that, moreover, they had not rusted when exposed for considerable periods to the atmosphere of the physical laboratory. He also found that, both with the usual microscopical reagents and also with new types developed for the purpose, the same steel, under different conditions of heat treatment, would sometimes etch and sometimes not. He was at once struck with these marked characteristics, and proceeded to investigate both the limiting ranges of composition for producing a steel practically resistant to ordinary corrosion and also the conditions of heat treatment necessary with any particular steel for developing to the greatest extent this resistance to corrosion." It is worth while noting that this discovery of the non-corrosive properties of stainless steel by Brearley in 1913 was something entirely new in the history of chromium steels, although they have been known for more than a century, and in 1821 Berthier published a paper on "The Influence of Chromium on the Corrodibility of Iron." It may be that stainless steel cutlery has not quite the cutting quality of the best plain carbon steel, but there is no doubt about the fact that, speaking practically, it is a non-corrosive and stainless material.

THE PROTECTION OF ALUMINIUM AND ITS ALLOYS.

The protection of aluminium and its alloys against corrosion can be secured by a specially prepared film. I have already commented on the fact that this metal is ordinarily covered with a protective film of oxide or hydroxide. It does not, however, constitute a perfect protection in the presence of corrosive liquids and even neutral salt solutions. The film tends to crack and lose its power of adhesion to the metallic surface. Local corrosion—pitting—then sets in. Moreover, this film is much more liable to crack when subjected to alternate wetting and drying, particularly at an air-liquid interface. Probably the interfacial tensions of metal, air and water operate in producing this result. The practical problem therefore consists in finding a method of forming a strong and tightly adherent film of oxide or hydroxide instead of the thin film. Mott showed that such a hydroxide film could

be formed by making the metal the anode in a bath of sodium hydrogen phosphate, and recommended this treatment as a protection against corrosion. Working for the Corrosion Research Committee of the Institute of Metals, and with the aid of financial assistance from the Department of Scientific and Industrial Research, Dr. Bengough and Mr. J. M. Stewart, during the years 1921–24, carried out a series of investigations starting from this point, and found that the film produced by "anodic oxidation" in a bath containing a chromate, bichromate, or, best of all, chromic acid, protects the metal much more effectively against corrosion. The full description of the process is contained in a publication by the Department of Scientific and Industrial Research, published in 1926, entitled "The Anodic Oxidation of Aluminium and its Alloys as a Protection Against Corrosion."

The process is carried out as follows:—"After thoroughly cleaning the surface of the aluminium or its alloy, it is immersed in a suitable bath, *e.g.*, dilute chromic acid along with a carbon rod. A small external electromotive force is applied so as to make the aluminium the anode and the carbon the cathode. The applied electromotive force is gradually raised to a value depending on the nature of the alloy and on the composition of the bath. Thus, with duralumin in a chromic acid bath the voltage may be safely raised to 50 volts. After treating for some time in this manner the surface of the metal becomes covered with a semi-opaque uniform white coating."

In carrying out the treatment, two practical points should be noted. The immersed material must consist only of aluminium or suitable aluminium alloys, since most other commercial metals are attacked by the treatment and prevent the raising of the voltage; also, the bath should be large compared with the material, otherwise the heat produced by the current would make it difficult to regulate the temperature of the bath. The coating seems to consist almost entirely of aluminium hydroxide in a glassy adherent form. The hydroxide is possibly hydrated to some extent, but the hydration cannot be much, since the coating can be heated to at least 350 deg. Cent. without changing in appearance or density.

The laboratory investigations were followed by successful experiments on a larger scale at the Royal Aircraft Establishment at Farnborough, by agreement with the Air Ministry, and the process, which is protected by patent, is now being worked in this country by several firms on non-exclusive licences from the Department of Scientific and Industrial Research.

In the foregoing two instances you will notice that the protective material in each case is the element chromium. In the previous section of the lecture dealing with new alloys, two out of the three, namely, high-speed cutting tools and nickel-chromium steels, also contain chromium. One of the most interesting facts which has emerged from my survey is the extraordinarily wide applicability of chromium as an alloying element in metallurgy.

The Royal Society's Conversazione.

THERE were few exhibits of direct engineering interest shown at the Royal Society's conversazione, which was held at Burlington House on Wednesday evening of this week. One of the most interesting of the scientific exhibits consisted of the applications of ultra-violet radiation shown by Mr. A. A. King, works manager of Albright and Wilson, phosphorus manufacturers, of Oldbury, near Birmingham. The equipment consisted of apparatus for the generation of ultra-violet radiation, which was freed from visible light by passing it through a filter of Chance's ultra-violet glass. The filtered radiation was directed on to various objects in a dark cabinet, and by the fluorescence produced in them enabled much to be learned regarding their constitution. For example, under the radiation genuine amber fluoresced, while imitation amber made of coloured glass did not respond. Distilled water fluoresced and thereby betrayed the fact that it still contained a certain amount of impurities. The fluorescence of ordinary laboratory distilled water was very marked, and even the purest of pure distilled water still showed a trace of fluorescence. Perhaps the most striking, and from the point of view of medical jurisprudence, the most important application of Mr. King's work is its use for the detection of arsenic in foodstuffs and other bodies suspected of containing it. The body to be examined is treated in a vessel in which hydrogen is being actively produced. Arsenurated hydrogen, if arsenic is present, is given off, and is caused to stain a paper sensitised with mercuric chloride, the paper being placed across an outlet from the vessel of known area. The paper is subsequently examined under the ultra-violet radiation. The mercuric chloride fluoresces blue, while the arsenic stain stands out as a black disc. By comparing the intensity of the black disc with that given by a known quantity of arsenic, the amount of arsenic in the subject being examined can be measured. By this means, we were informed, quantities of arsenic as small as 0·000,000,01 gram—one hundred millionth of a gram—can be detected and estimated quantitatively. We understand that this refinement is a hundred-fold greater than that reached by previous methods. Arsenic stains which are quite invisible in ordinary light show up under the ultra-violet radiation as quite strong black discs. The apparatus is obviously of ominous significance to anyone contemplating the use of weed-killer for other than its normal purpose.

Dr. W. Rosenhain, of the National Physical Laboratory, showed some specimens illustrating the metallography of solid mercury. These specimens were prepared by solidifying the metal, which melts at — 39 deg. Cent., in liquid air or carbon dioxide snow, and etching in an aqueous solution of hydrochloric acid (freezing point — 86 deg. Cent.). During manipulation and examination the metal is maintained in the solid state by immersion in liquid air or carbon dioxide snow and acetone. Condensation of frost on the specimen and the objective lens of the microscope is prevented by enclosing the specimen and the lens in a chamber through which passes a stream of cooled, dried air.

Another exhibit from the National Physical Laboratory consisted of specimens of the very pure metals about which papers were presented at last week's meeting of the Iron and Steel Institute. The specimens shown were of iron, manganese, chromium, silicon and beryllium. For the three first-named metals, it was claimed that the impurities present could only be detected spectrographically. The silicon shown had a purity of 99·95 per cent. and the beryllium a purity of 99·8.

The Cambridge Instrument Company showed a magnetometer of the "null" type, designed by Dr. F. E. Smith, for measuring the horizontal component of the earth's magnetic field. The same company exhibited an improved form of Paschen galvanometer, in which the moving system consists of two groups of cobalt steel magnets, which are so made as to ensure uniformity of physical condition and size, thus ensuring almost perfect astaticism. The system is protected from external magnetic fields by a shield of mumetal surrounded by a mild steel tube and by an outer gunmetal shield.

Professor B. P. Haigh exhibited his model of a 6in. shaft rotating in a 7½in. bearing, which he has designed to demonstrate the Osborne Reynolds theory of the flow of lubricants in bearings. This model was shown at a recent meeting of the Institution of Mechanical Engineers, and attracted considerable attention by virtue of the fact that it made visible features of the flow which previously had been appreciated only by means of mathematical analysis.

Sir Robert Hadfield exhibited specimens of the alloys of iron and manganese low in carbon, which formed the subject of the research described in his paper read last week before the Iron and Steel Institute. He also showed specimens of high-tenacity non-corrodible steel used as reinforcement bars in the preservation of St. Paul's Cathedral in replacement of the original wrought iron bars employed by Sir Christopher Wren.

Lieut.-Commander F. J. C. Allen demonstrated the working of a new form of thermostat. The operation of this thermostat, which is for use in conjunction with electric circuits, depends upon the fact that magnetic metals lose their magnetism at certain given temperatures, and alloys of these metals can be made to vary the temperature at which the change occurs. In the "on" position an armature is held up by attraction to a controlling arm in a suitable position to be affected by heat, such arm being partly or wholly made of magnetisable material. On a given temperature being reached this armature is released and falls on a switch, thereby cutting off the current and the temperature of the apparatus is reduced, when the armature is again lifted, and the current switched on.

The Research Laboratories of the General Electric Company demonstrated Selényi's method of observing the "clean-up" in a vacuum lamp. The vacuum inside a lamp just removed from the pumping system is considerably worse than the vacuum in the same lamp after it has been burned at a considerable overvoltage for a few minutes. The well-known process which brings about this improvement in the vacuum is known as the "clean up." Residual gas in the lamp is absorbed by the walls of the bulb under certain conditions, and this absorption is usually coincident with an electric discharge which takes place across the space between the two filament electrodes. Selényi's method of observing this discharge is to turn the lamp into a system of condensers by partially immersing it in water. One condenser is formed by the filament system and the inner bulb surface, and the other by the inner and outer bulb surfaces. If an oscillating potential is applied between the water and one end of the lamp filament, a note characteristic of the capacity of the lamp condenser can be heared in a pair of telephones or loud-speaker inserted at an appropriate point. The oscillating potential is supplied from the two terminals of a "flickering" neon lamp. If an adjustable voltage is applied to the lamp filament and its value gradually raised a point is reached when ionisation of the residual gas in the lamp sets in. The gas is now conducting, and therefore forms a non-ohmic shunt across the condenser formed by the filament system and inner bulb surface. Hence, the effective capacity of the lamp condenser is changed and the note in the telephones decreases in pitch. As soon as absorption of the gas starts, the number of ions decreases again and the note in the telephones rises in pitch. When the "clean-up" is completed, the note in the telephones remains at a constant pitch. By this means it is very easy to tell if any lamp has not "cleaned-up."

BOLIVIAN RAILWAY CONSTRUCTION.

IT is announced from La Paz that contracts will shortly be placed for the completion of the Ferrocarril La Paz-Yungas, to cover eventually a distance of 135 kiloms. (84¼ miles), of which 85 kiloms. have been opened to traffic. Construction began as far back as 1915. It is intended to extend the line eventually to the head of navigation on the Beni River. If the proposals of the promoters are realised, the Pacific will likewise be connected with other rivers of the Amazon basin, thus establishing a trans-continental route between the Chilean port of Arica, on the west coast of South America, and the Brazilian port of Pará, on the east coast. This line will be one of the loftiest in the world, the second built in South America to cross the Grand Cordillera, and considerably higher than the line between Los Andes and Mendoza, Argentina.

The section of the La Paz–Yungas line now under construction is from Huichuloma, 50 kiloms. from the capital. This part of the work should have been completed in 1924, but political disturbance and lack of funds intervened. From Huichuloma the track will be continued for 10 kiloms. as far as Yerbani, from which point motor roads will be built to the two principal sections of the Yungas region, one to Coroico and the other to Chulamani. The respective altitudes attained are 6500ft. and 5440ft. The work, which is entirely under the charge of Bolivian engineers, is among the most difficult on any of the Bolivian railways. The principal difficulties have arisen from the marked difference in elevation, in surmounting which it has been necessary to cross several narrow valleys, which in many places resemble imposing canyons where room for the road bed could not be found without expensive constructional work. Some idea of the difficulties may be obtained from the fact that, on rising from La Paz—altitude 12,000ft.—the line has to pierce the principal ridge of the Andes and pass through a gap 15,224ft. above sea level. This difference in altitude is to be surmounted by means of a track only 15 miles in length, with a gradient which averages about 4 per cent., but which at one point is considerably steeper than that. The highest point on the line is La Cumbre—15,258ft.—from which the track descends to the lower level by a steep slope through a deep, but relatively wide, valley, and thence through the bottom of the Uduavi Pass. The descent is made over a gradient of 6 per cent. Between the summit and the point Pongo there are not more than 2 or 3 miles of straight track, the difference of altitude being 3937·2ft. Switchbacks, a frequent feature of mountain lines in South America, are avoided by a number of horseshoe bends, the radius of the curves being reduced to 196·86ft. A continuous line, which can, it is said, be operated without difficulty with specially constructed locomotives, is thus followed. Most of the cuts are in rock—generally slate. When the line is completed it is estimated that 20,000 tons of freight a year will be carried, one of the principal items being coca leaves. Hitherto transportation has been effected by mules.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

TORSIONAL FATIGUE.

SIR,—With reference to the report of my remarks on torsional fatigue at the Institution of Mechanical Engineers given in your issue of May 6th, page 488, I wish to be allowed to confirm the general inference of your editorial footnote, although the exact figures are slightly lower than those quoted.

My experiments show that a mild steel specimen was unbroken after 10 million shear stress cycles of 10·4 tons per square inch to 28·8 tons per square inch, the ultimate tensile strength of the material being 31 tons per square inch and the ultimate torsional strength 32 tons per square inch. The safe range of shear stress for this material for reversed stresses—10 million stress cycles basis—was 20·8 tons per square inch. Similarly, a normalised 0·6 per cent. C steel specimen was unbroken after 10 million shear stress cycles of 18·5 to 44·5 tons per square inch, the ultimate tensile strength and also the ultimate torsional strength being 50 tons per square inch. The safe range of shear stress for this material for reversed stresses was 28·6 tons per square inch.

The modified Goodman law expresses the relation between the safe range of stress and the mean stress in the form—

$$R = R_r\left(1 - \frac{M}{f}\right)$$

where R = safe range when M is the corresponding mean stress;
R_r = safe range for reversed stresses (M = 0);
f = ultimate strength of the material.

This formula assumes that the safe range of stress is zero at the ultimate strength of the material, and gives considerably lower values than the experimental results quoted above.

G. A. HANKINS.

Teddington, Middlesex, May 9th.

IRON AND STEEL INSTITUTE.—For two or three years past certain of the leading Spanish members of the Iron and Steel Institute have been contemplating the possibility of arranging to hold a meeting of the Institute in Spain, the last one held in that country having taken place in 1896. A small advisory committee has been formed, with Mr. Alfonso de Churruca, assistant director of the well-known company, Altos Hornos de Vizcaya, and a member of the Cortes for the Province of Guipuzcoa, as chairman, and with Mr. Luis Barreiro as hon. secretary. Mr. Barreiro took the opportunity, on behalf of Mr. Churruca and his colleagues, at the annual meeting of the Institute last week, to convey a formal invitation to the Institute to hold its autumn meeting in 1928 at Bilbao. The details of the programme are not yet definitely settled.

Railway Matters.

THE services of Colonel Norris G. Bell, as the Chief Commissioner of the Commonwealth Railways of Australia, are to be available to the Federal Government for another two years. His term of office has been extended more than once, and has now been renewed to November, 1929.

THE Coleraine-Portrush branch of the Northern Counties section of the London, Midland and Scottish Railway is about 2 miles from the picturesque seaside resort of Portstewart, and the railway company provided a tramway, 1 mile 67 chains long, to fill the gap. Motor omnibus competition made the tramway unprofitable, and it was recently removed. A big scheme is now in contemplation, which is nothing less than the deviation of the branch so that it will pass through Portstewart.

ON page 382 of THE ENGINEER of April 8th it was announced that Mr. C. F. Slade, the district engineer of the London and North-Eastern Railway at Cambridge, had been removed to London to be the King's Cross district engineer. It is now announced that Mr. B. P. Fletcher, the chief assistant to the Newcastle divisional engineer, has been made district engineer at Cambridge. We take advantage of making this announcement to mention that when the series of articles "One Hundred Years of British Railways," that appeared in the volume for the second half of the year 1924, was in preparation, Mr. Fletcher rendered us considerable assistance when going over some of the old "waggon-ways" in Durham that preceded the "rail-ways."

IN the course of an address recently delivered before the New England Railway Club in Boston, Mr. C. W. Gennet, jun., an inspecting engineer, mentioned the fact that one prominent mid-western railway in America, noted for its excellence of road bed and track and the accuracy of its rail records, exactly 2700 rails had broken or failed in the twelve months ended October 31st, 1926, on a total of 4716 miles of track. Of these failures, 586 were due to transverse fissures universally recognised as the most dangerous type of failure. Other failures to the number of 1773 were of the head type, which, while not particularly dangerous, are, nevertheless, cause for constant anxiety and additional expense. This railway therefore had slightly more than seven rail failures every day, while an actual transverse fissure showed itself every fifteen hours.

IT is not generally understood that the Railways Act, 1921, was not universal in its application. It exempted, for instance, all jointly owned and all light railways. Such companies necessarily will need the same benefits as the grouped companies in the matter of rates and charges. Sec. 33 of the Act therefore provided that the Rates Tribunal shall apply to each such company, the schedule of charges of such one of the amalgamated companies as appears to the Tribunal to be most appropriate to the case of that company. The non-amalgamated companies, as they are called in the Act, some sixty-two in number, have now made their selection of the company's schedule each prefers, and public notice has been given asking for objections, if any, to be lodged before the 27th inst. It may be added that the selected schedule is, in each case, that of the neighbouring big company.

A MESSAGE from Mexico City states that a project has been submitted for the filling up of the 75-mile gap between Presidio and Alpine, in the State of Texas, the uncompleted part of the Kansas City, Mexico and Orient Railway. Owing to formidable engineering difficulties this construction has hitherto been found impossible; but when this last link is built, Kansas City, in Missouri, and Topolobampo, on the Pacific coast of Mexico, will be joined, this being the first trunk-line to cross the frontier between the Republics. On a large part of the track the rails will be of 75 lb. to the yard with the most modern fish-plates, points, &c.; the sleepers, laid closely together, will be of tarred redwood from the forests of Lower California. The terminus of the system on Topolobampo Bay will be of great commercial importance. Topolobampo ranks as one of the finest ports on the West Coast of Mexico, being completely mountain-locked, having an area of about seven square miles and a depth over the bar at the entrance, at low tide, of about 22ft. It is proposed to deepen the bar to some 35ft. so as to enable vessels drawing 33ft. of water to pass in at low tide and approach within 100ft. of the shore on the north side of the Straits of Jossun, which will then become the commercial front of the port. From Topolobampo the Kansas City, Mexico and Orient Railway will control a large number of well-built passenger and cargo boats serving the west coast and work in connection with steamers to the Orient.

THE anniversary of the general strike prompts the thought that it was accompanied by three serious railway accidents, all of which occurred on the same day—Monday, May 10th, and all were on the London and North-Eastern. The first was, in a sense, the most serious, as it was a wilful derailment. Some miners took a rail out of the up main line near Cramlington, north of Newcastle, so that the up morning East Coast express was derailed, but, fortunately, without any serious personal injuries. Six miners were subsequently tried and convicted for the offence and were sentenced to long terms of penal servitude. The second accident was at Bishop's Stortford. A goods train with garden produce was dispatched from Cambridge. It was driven by a volunteer who travelled at a higher speed than he should have done, and so caught up and ran into a preceding passenger train. One passenger was killed, but he was out of the train. The damaged coaches struck the roofing over the platform and some of it, in falling, fell on the passenger on his way from the train. The third, wherein three passengers were killed, occurred at St. Margaret's, Edinburgh. Some wagons were being shunted, which caused the down line to be obstructed. The traffic inspector who was acting as signalman failed to advise the next man in the rear of this, and he also omitted to ask if he might send a passenger train forward. Finally the driver—a volunteer—of the latter travelled at a higher speed than was warranted, and failed to stop short of the wagons. There were other accidents during the general strike, but none of them justified an inquiry by the inspecting officers of railways.

Notes and Memoranda.

IT is estimated that the mineral contents of the Dead Sea are worth, on current quotations, £257,524,000,000.

WORK on piercing the tunnel for the Mandi hydro-electric scheme, India, should be started during July or August.

A TIMBER trestle bridge built by a logging company near Tacoma, Washington, is claimed to be the highest in the world. It is 204ft. 6in. high by 893ft. long, and contains 836,000ft. board measure of timber.

ACCORDING to figures prepared in the Forest Service of the Department of the Interior, there were 5529 forest fires in Canada last year which burned over a total area of 1,824,015 acres. The total gross damage and loss is estimated at 7,468,343 dollars.

IN cleaning up the site of the old Langlaagte Estate Gold Mine, South Africa, after it was shut down, as much as 311 oz. of gold was recovered. Including previous cleanings 22,405 oz. were recovered altogether. During its life the mine raised some 12,000,000 tons of ore.

IN a paper presented to the American Electrochemical Society, Mr. Heihachi Kamura said that by means of gaseous reduction, with CO, at a temperatute of 950 deg. Cent., he secured nearly perfect reduction of iron ore of 1in. size. The sponge iron produced was practically free from P, S and Mn.

IT was desired to lower a concrete slab measuring 18ft. by 20ft. and weighing 19 tons a distance of 18in. at St. Petersburg, Florida. It was found impracticable to use jacks, as none were available which would shut down to the minimum height. The slab was consequently supported on blocks of ice, and these were allowed to melt away until the new bedding was reached.

THE feat of producing a reservoir with a capacity of 460,000 acre-feet by means of a dam containing only 90,000 cubic yards of concrete, is described by the *Engineering News-Record*. The dam is on the Skokomish River, Oregon, and increases the level of Lake Cushman by 170ft. The dam is of the arch form, and is 250ft. high. The power produced amounts to 50,000 horse-power.

WHAT is claimed to be a record in steel production for this country has been achieved by the new furnace at the Dowlais Iron and Steel Works, Cardiff, of Guest, Keen and Nettlefolds, Ltd. The output during one week recently was just over 3400 tons. During the preceding eight weeks the average output was 3000 tons a week. The furnace is mechanically charged with calcined iron ore from the company's mines in Spain, and is believed to be capable of even greater production.

IN commenting on the failure of a flexible metallic steam pipe on an engine-makers' test bed, the Engineer Surveyor-in-Chief, Board of Trade, says:—Flexible steam pipes are liable to damage if they are carelessly handled or are bent to a curvature of smaller radius than their construction readily permits. The serious consequences of their failure may not be realised. The damage may not be detected by inspection, and it is prudent to test such pipes frequently by hydraulic pressure to about twice the working pressure for which they are intended.

ACCORDING to the *Chemical Trade Journal* three new metallic alloys that have been discovered and patented by Mr. T. D. Kelly, of London. Two of these alloys are iron copper chromium alloys and are stated to be cheap and surprisingly resistant to attack by corrosion and strong acids. The other alloy, no technical particulars of which have been disclosed, has been termed Solium, and is stated to be a complete substitute for platinum, whilst it can be sold at 5s. per ounce. It is also reported that Mr. Kelly is at present engaged in negotiations with representatives of American and German combines with a view to forming a company to manufacture his alloys.

DURING the process of cleaning up the old plant of the Llanglaagte Gold Mine the steel extractor boxes, some of which had been in use for over twenty-five years, were scaled after being put out of commission. The return was good, so they were painted first with salammoniac and afterwards with strong hydrochloric acid, and allowed to stand for a fortnight, when they were again scaled. The results were so encouraging, says the *S.A. Mining and Engineering Journal*, that the process was carried on for twelve months. The total recovery from this source was 1450 oz. from twenty-three boxes. The absorption of gold in the steel is not easily accounted for, as the returns from the treatment of similar boxes in other mines varies greatly.

IN a recent official report on the failure of a tube in a water-tube boiler at a Lancashire power station, it is explained that it had been the custom to introduce a boiler fluid into the feed water to act as a reagent for the prevention of scale on the heating surfaces in the boilers; otherwise the feed water is not treated. Up to the time of the explosion it had never been considered necessary to have the tubes in any of the boilers cleaned except by passing a wire brush through them in order to remove loose deposits. From the evidence obtained it would appear that renewals of tubes have frequently been found necessary. It is stated that the usual reason for renewal has been the formation of local blisters on the tubes, and in some cases a small hole developed on the enlarged part thus giving warning of weakness before a serious failure took place.

SOME experiments carried out by the Department of Scientific and Industrial Research into the storage of fruit in gas are described in Report 30 of the department, recently published (1s. 9d. net). In this piece of research the idea of using artificial atmospheres in order to retard the ripening of fruit in transit has been fully examined and tested, and the conclusions drawn from the experiments are reported. In the whole series of experiments apples were stored in chambers containing varying percentages of carbon dioxide and oxygen, and, though there were unexpected complications in some cases, the general effect was to preserve the fruit for much longer periods than it could have been kept in normal conditions. It was found that atmospheres containing about 10 per cent. of carbon dioxide, with an equivalent reduction of oxygen to about half its normal value, were most effective.

Miscellanea.

A COAL seam over 9ft. thick has been discovered on the property of the St. George's Coalfields, in Newfoundland.

A REPORT of the Russian geological mission appointed to investigate the potash salts reserves at Solikamsk, states that the deposits reach a depth of 300 m., and cover an area of not less than 120 square kilometres.

A DISCOVERY of valuable oil shale in the Lonquimay Valley, near the head waters of the Rio Bio-Bio, is reported, and a concession to work the shale has been granted by the Chilean Government to an American syndicate. It is said that process tests of the shale have yielded approximately 50 gallons of light grade oil per ton.

A COMMUNICATION from Oslo states that, after successful experiments, plans have been elaborated for the construction of a great factory at King's Bay for the production of synthetic petrol and other by-products from Spitzbergen coal. Before effect is actually given to the plans, investigations will be made concerning the extent of the coalfields around King's Bay.

As the reserves of manganese ores in the country are inadequate, the steel trade of the United States is, according to the *Ironmonger*, promoting research in the direction of the recovery of the manganese contained in slag from open-hearth furnaces. Since the use of high-manganese irons in such furnaces became general, the slag has been found to contain as much as 8 per cent. of manganese.

THE Corporation of Glasgow has obtained approval of an order for the construction of a new bridge over the Clyde at Finnieston, which will cost £1,000,000 and will meet the traffic and industrial development which is tending to spread westwards. The bridge will be a high-level one, and will obviate the necessity for the four ferries and a harbour tunnel. It will be the only bridge westwards of the centre of the city.

THE Santo Domingo Government is about to contract for structural improvements at the port of Santo Domingo, at the mouth of the Ozama River; at Puerto Plata, the principal seaport on the northern coast; and at San Pedro-de-Macoris. Work at the last-named port has already commenced. Extensive warehouses and a landing stage are to be erected; landing at present has to be effected from steamer to lighter and thence to shore.

THE fourth International High-Tension Transmission Congress is to be held in Paris from June 23rd to July 2nd. The work of the Conference will be divided into three main divisions, to each of which two days will be allotted. These divisions will consider respectively the production of power, the construction of transmission lines, and the operation of transmission systems. Two days will be devoted to excursions and visits to electrical installations in the Paris district.

ACCORDING to *The Times*, British rapid-hardening Portland cement has been imported from England for the re-paving of Broadway, New York, since this is the only Portland cement which hardens quickly enough to meet the requirements of the New York city engineer's specification. The lorries delivering the sand and stone to the site have been specially designed with seven divisions, each division containing 1 cubic yard of material, mixed in the proportion of three parts of sand to six parts of broken stone. The divisions are emptied separately into a hopper, where the necessary cement is added; the hopper is then elevated into the mixer, and the concrete is ready for placing without any further handling.

To meet the difficulty of keeping roads in a good state in spite of the growing motor traffic in Sweden, a new road covering substance has been invented by the Swedish engineer, Mr. John Behmer, of Eskilstuna, the main component of which is bitumen. The new road covering will, it is stated, stand a weight 1·45 times as great as that which the ordinary asphalt layer will stand at 19 deg. Cent., while at 50 deg. Cent. the Behmer covering has four times the resistance capacity of the ordinary asphalt covering. The covering is applied under high pressure by a machine similar to a steam roller. In eight hours the machine will, it is reported, cover an area of 5760 square metres. It is said that the new road surface is extraordinarily strong, while its cost does not exceed that of an ordinary macadam road.

AN irrigation project has been submitted to the Mexican Government calling for the construction of a large dam in the Rio Santiago canyon, not far from Aguascalientes. The reservoir, which will be known as the Calles Reservoir, after the President of the Republic, will be able to store 320,000,000 cubic metres—or over 70,000,000,000 gallons—of water in a natural basin, and the dam will be about 73 m. high and 380 m. across. At the site the elevation of the river bed is 1960 m. At the foot of the dam an electric plant capable of developing 3000 kilowatts will be installed, and power will be supplied to Aguascalientes, which has a population of 57,000, and several mines in the district. A secondary dam, 35 m. high, will be built at the further end of the canyon to form the point of outflow for irrigation canals which will serve an agricultural area of about 20,000 hectares.

IN the course of dealing with various applications relating, *inter alia*, to the provision of distributing mains the Electricity Commissioners have noted that the practice prevails in some cases of laying distributors of so small a sectional area as to tend to restrict or preclude the use of such distributors for dealing with any development of the domestic load. It has been observed, in a number of such cases, that the cost of excavation, reinstatement and jointing has exceeded the cost of the cable itself; and that, by a comparatively small additional expenditure on cable of a larger size, provision could have been made for dealing with a load at least twice as great as that possible with the cable actually laid. In view of the increasing demand for electricity for domestic purposes, and of the developments which may reasonably be expected during the next few years, the Commissioners desire to urge that authorised undertakers should, in general, adopt the policy of anticipating such demands by the provision of distributors of adequate section. They suggest that, except in special cases, distributors having a cross section of not less than 0·05 square inch should, as a general rule, be provided.

20,000-KILOWATT STEAM TURBINE AT ROTTERDAM

C. A. PARSONS AND CO., LTD., NEWCASTLE-UPON-TYNE, ENGINEERS

(*For description see page* 512)

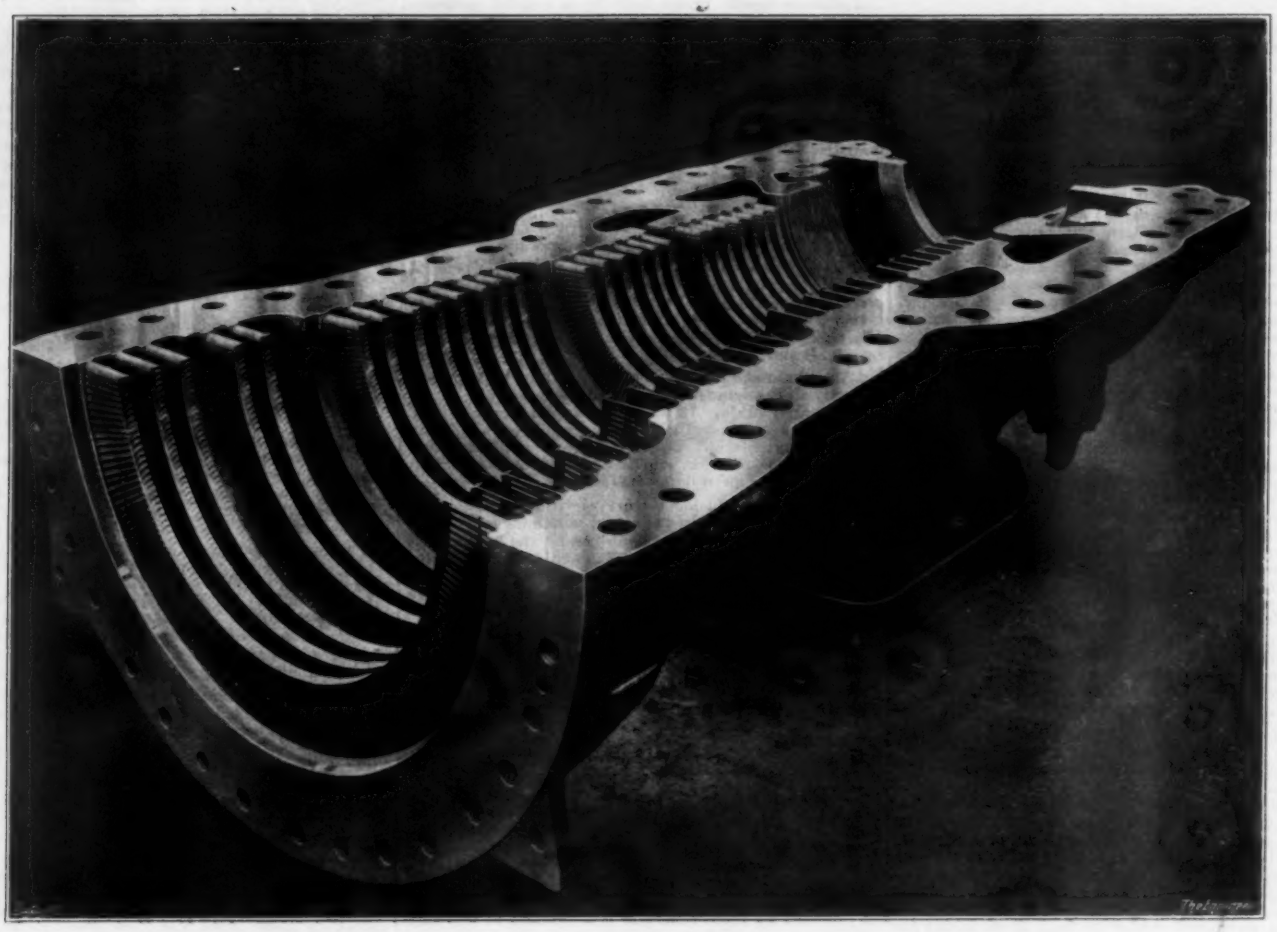


FIG. 3—TOP HALF OF HIGH-PRESSURE CYLINDER

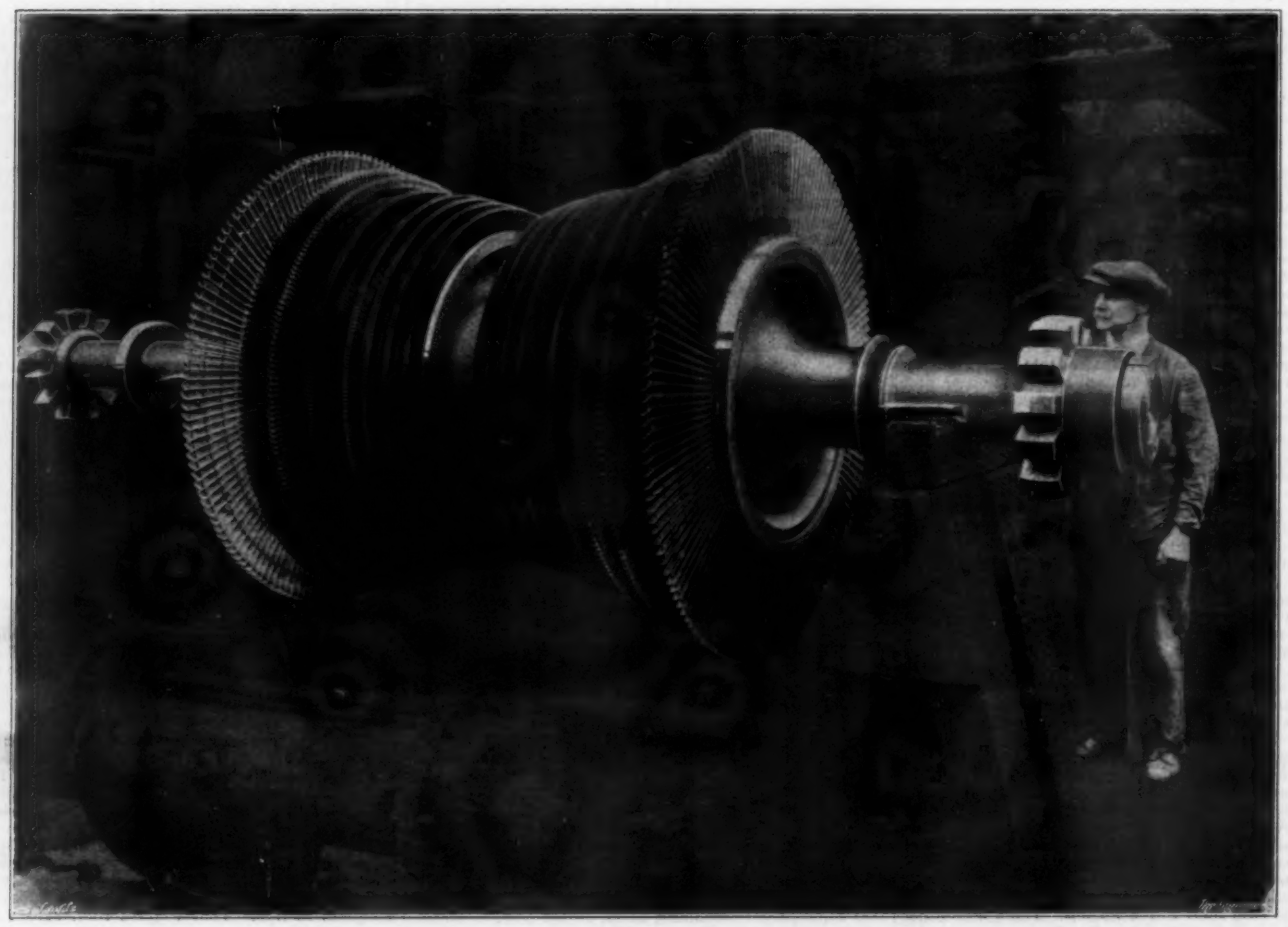
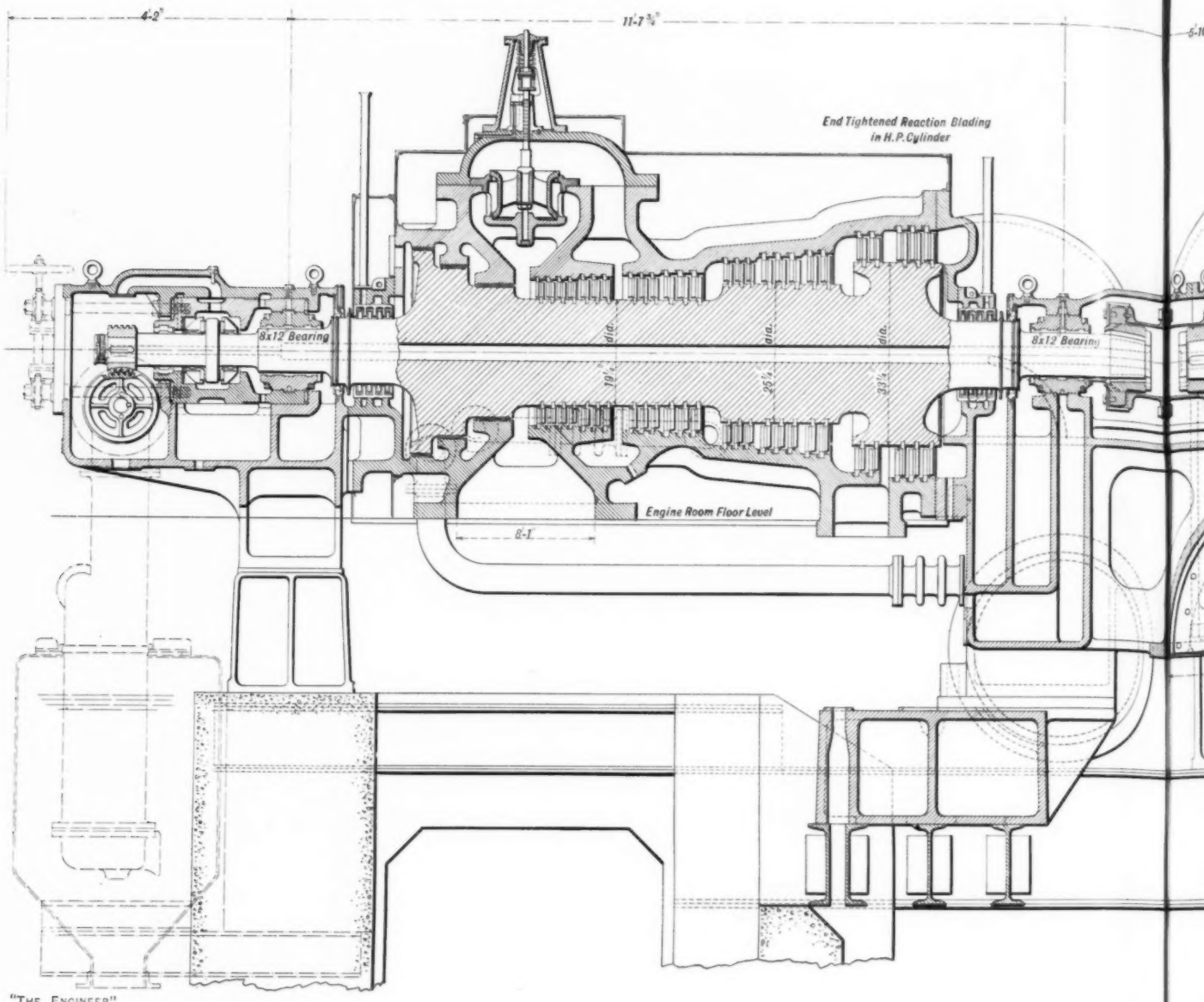


FIG. 4—LOW-PRESSURE ROTOR

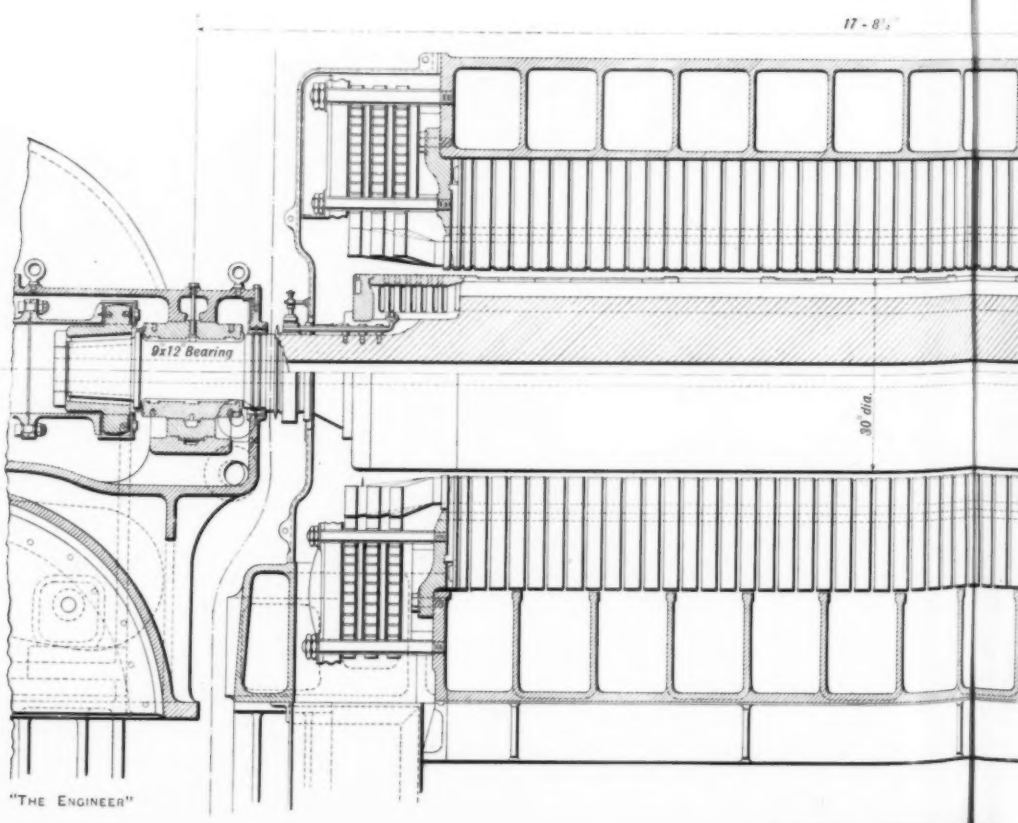
20,000-KILOWATT TURBO-ALTERNATOR AT TH

C. A. PARSONS AND CO. LTD. NEWC



"THE ENGINEER"

LONGITUDINAL SECTION T

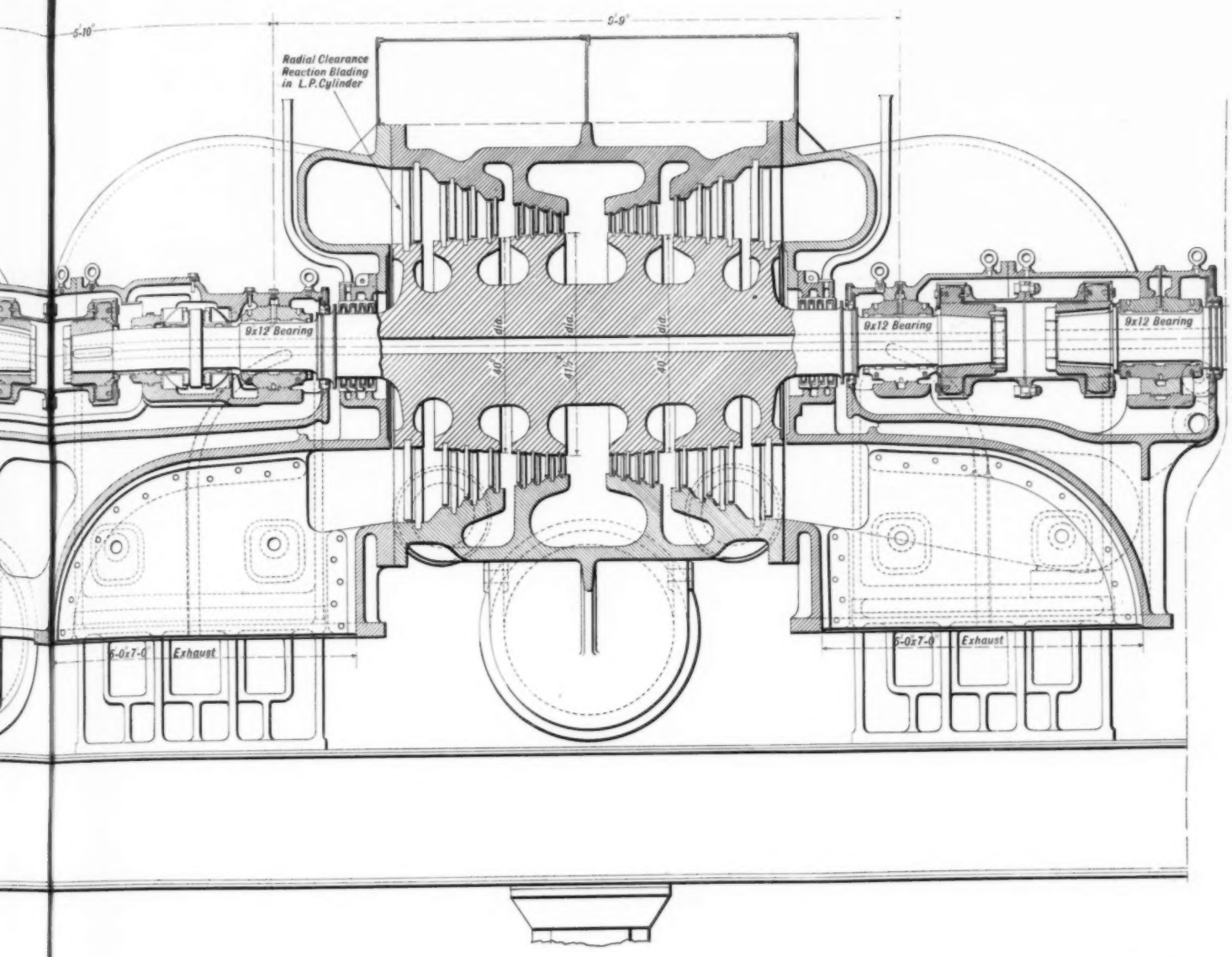


"THE ENGINEER"

LONGITUDINAL SECTION THROUGH

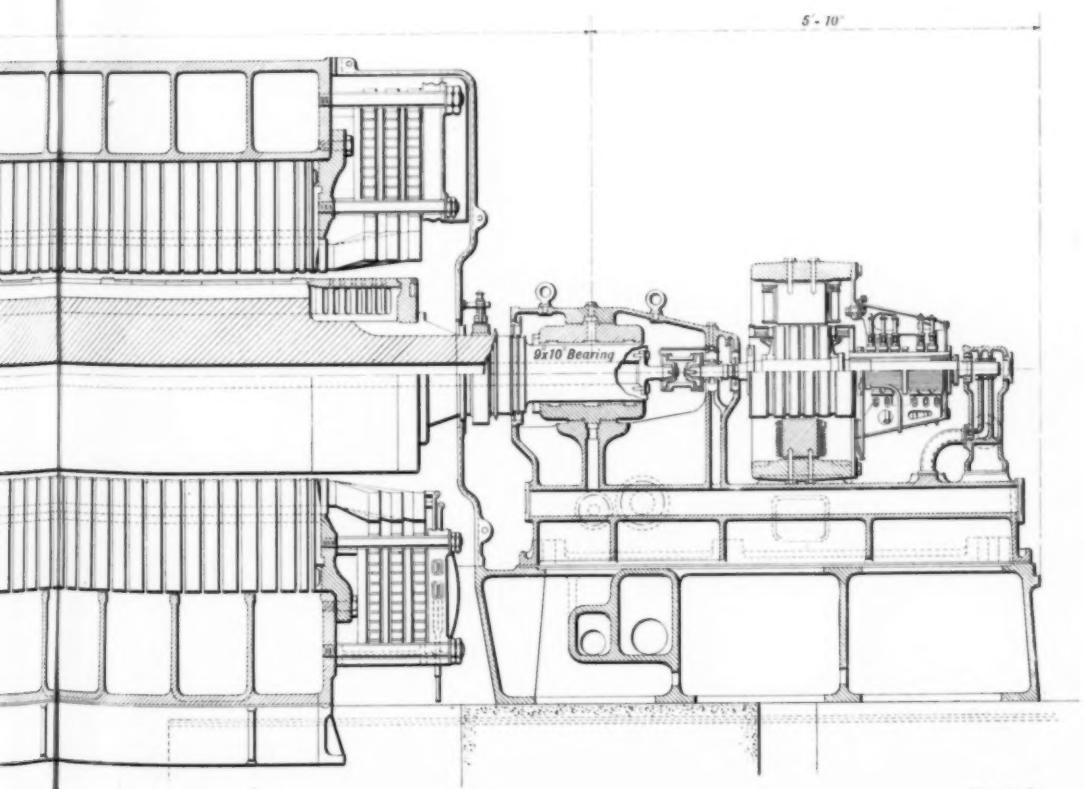
THE SCHIEHAVEN POWER STATION, ROTTERDAM

LTD. NEWCASTLE-UPON-TYNE ENGINEERS



SWAIN Sc

DINAL SECTION THROUGH TURBINE



SWAIN Sc

ION THROUGH ALTERNATOR AND EXCITER

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.

CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.

EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.

FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris.
CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.

GERMANY.—FRITZ REHFUS, Blumenthalstrasse, 10, Cologne.

BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND CO., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.

ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.

JAPAN.—MARUZEN CO., Tokyo and Yokohama.

AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND CO., Johannesburg, East London, and Grahamstown.

AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
MELVILLE AND MULLEN, Melbourne.
ATKINSON AND CO., Gresham-street, Adelaide.

CANADA.—DAWSON, WM., AND SONS, Limited, 87, Queen-street East, Toronto.
GORDON AND GOTCH, Limited, 132, Bay-street, Toronto.
MONTREAL NEWS CO., 386–388, St. James-street, Montreal.
TORONTO NEWS CO., 42, Yonge-street, Toronto.

CEYLON.—WIJAYARTNA AND CO., Colombo.

JAMAICA.—EDUCATIONAL SUPPLY CO., Kingston.

NEW ZEALAND.—GORDON AND GOTCH, Limited, Wellington and Christchurch; UPTON AND CO., Auckland; J. WILSON CRAIG AND CO., Napier.

STRAITS SETTLEMENTS.—KELLY AND WALSH, Limited, Singapore.

UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., 83 and 85, Duane-street, New York; SUBSCRIPTION NEWS CO., Chicago.

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post Office Order must be made payable to THE ENGINEER and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly ..	£1 11s. 6d.	Half-yearly	£1 13s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum.
Thick paper edition .. £3 3s. 0d. ,,

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The Charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "THE ENGINEER DIRECTORY," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

"THE METALLURGIST"—BINDING CASES.

Cloth Binding Cases for twelve issues (one year) .. .. 2s. 0d.
Subscribers' own copies, including cases, bound Cloth .. 4s. 0d.
Bound half roan 7s. 6d.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two-page plate illustrating a 20,000 Kilowatt Turbo-alternator at the Schiehaven Power Station, Rotterdam. Every number, as issued by the Publisher, contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper from this office.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, May 13th, 1927. PAGE

A SEVEN-DAY JOURNAL .. 511
20,000 K.W. PARSONS TURBO-ALTERNATOR AT ROTTERDAM. No. I. (Illus.) .. 512
IRON AND STEEL INSTITUTE. No. I. (Illus.) .. 513
SUCTION GAS FOR COMMERCIAL VEHICLES. No. II. (Illus.) .. 516
THE MODERN STEAM ENGINE AND INTERNAL-COMBUSTION MOTORS. No. V. (Illus.) .. 518
PAINT-MAKING MACHINERY. No. V. (Illus.) .. 519
SOME RECENT SERVICES OF METALLURGY TO ENGINEERING .. 520
THE ROYAL SOCIETY'S CONVERSAZIONE .. 522
BOLIVIAN RAILWAY CONSTRUCTION .. 522
LETTERS TO THE EDITOR—Torsional Fatigue .. 522
RAILWAY MATTERS—NOTES AND MEMORANDA—MISCELLANEA .. 523
LEADING ARTICLES—
The Trades Disputes Bill .. 525
Metallurgists and Engineers .. 525
Torsional Fatigue .. 526
LITERATURE .. 526
BOOKS RECEIVED .. 526
THE GROWTH OF CRYSTALS IN SUPER-SATURATED LIQUIDS .. 527
SIXTY YEARS AGO .. 527
A 1000 B.H.P. AIRLESS INJECTION MARINE OIL ENGINE. No. I. (Illus.) .. 528
CENTRAL SCOTLAND ELECTRICITY SCHEME .. 529
INTERACTIONS OF GASES AND ORE IN THE BLAST-FURNACE .. 530
INDUSTRIAL BURSARIES IN METALLURGY .. 531
INSTRUMENT TRANSFORMERS AND RECORDING AMMETERS, VOLTMETERS AND WATTMETERS .. 531
A NEW LIFEBOAT LAUNCHING TRACTOR. (Illus.) .. 531
THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS .. 531
TEN-STAGE CENTRIFUGAL FEED PUMP. (Illus.) .. 532
CUBICLE SWITCHGEAR. (Illus.) .. 532
PROVINCIAL LETTERS—
The Midlands and Staffordshire—Lancashire .. 533
Sheffield—North of England—Scotland—Wales and Adjoining Counties .. 534
INSTITUTION OF NAVAL ARCHITECTS .. 535
PERSONAL AND BUSINESS ANNOUNCEMENTS .. 535
CONTRACTS .. 535
CURRENT PRICES FOR METALS AND FUELS .. 536
FRENCH ENGINEERING NOTES .. 537
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 537
FORTHCOMING ENGAGEMENTS .. 538

TWO-PAGE SUPPLEMENT—20,000 KILOWATT TURBO-ALTERNATOR AT THE SCHIEHAVEN POWER STATION, ROTTERDAM.

THE ENGINEER.

MAY 13, 1927.

The Trades Disputes Bill.

Now that the turmoil which arose both within and outside the House of Commons as a result of the introduction of the Trades Disputes Bill has to some extent abated, it is possible to take a calmer view of the situation. Two points are reasonably plain. In the first place, the Government is determined to place the measure on the statute book; and in the second place, the Opposition is determined to oppose the whole measure, root and branch, without making any attempt to amend or modify its provisions. Indeed, the Opposition leaders outlined a course of action before they saw the text of the measure; they not only decided strenuously to oppose its every clause, but gave out that, when returned to power, they would secure its deletion from the statute book. He who would understand the reason for the extraordinary excitement aroused by the second reading of this measure in the House of Commons should bear in mind the significant change in the law which was made by the Trades Disputes Act of 1906. When that measure was passed by the House of Commons we wrote these words—see THE ENGINEER, November 9th, 1906:—"If the Bill becomes law in its present form we shall no longer be able to boast of the maxim *Ubi jus, ibi remedium*; it must in future run: 'There is no wrong without a remedy unless that wrong is done (*a*) by a trade union, or (*b*) in furtherance of a trade dispute.'" The Bill was passed by Lords and Commons, and in that form it has been part of the law of the land ever since. Writing of it in *The Times* last January, Dr. Shadwell said:—"What has been the cost to the country defies calculation. It ought to have been called the Trades Disputes Encouragement Act. If the Legislature had set itself to do what it could to promote disputes it could not have devised a better means of divesting those engaged in them of all legal responsibility for their own conduct, however injurious it may be."

Having used "the strike"—in its larger sense—so long with impunity and to what they conceive to be the advantage of those whom they serve, it is not surprising that the leaders of the industrial classes should cry out when an attempt is made to restrict their powers. But notwithstanding all that has been said, the fact remains that the Bill now before the House of Commons does very little to curtail the privileges conferred by the Act of 1906. True, it is to make a strike which is intended to intimidate the Government or any substantial portion of the community illegal; it seeks to prevent intimidation; it may prevent the civil servant from joining a trade union; it requires that a man shall "sign on" rather than "sign off" the political levy; but these matters apart, it leaves the position of those who take part in the lawful strike exactly where it was before. There is no lack of evidence that the community as a whole takes a rational view of the proposed legislation. Notwithstanding all the noise in the House of Commons, the working classes seem to concern themselves very little about the matter. As Mr. Spencer pointed out in the House, "Enthusiasm engineered from the top usually fails. The movement against the Bill has not sprung spontaneously from the workers, and in my view it is destined to fail." In the main opposition outside the House has been confined to the leaders. Nor do we anticipate that it will be possible for them, in spite of their considerable power on the platform, to awaken antagonism against a measure which they know and which every plain man will soon realise is in the main only designed to prevent violence and intimidation.

Even if it contained no other provision of importance, the fact that this measure roundly proclaims the illegality of a general strike is sufficient to justify its being placed upon the statute book. Many opponents of the Bill, of course, have quoted the judgment of Mr. Justice Astbury in support of the proposition that the general strike of last year was illegal. But there are many lawyers who take a different view. They have pointed out, with considerable force, that his was an offhand judgment given in a case in which the defendants were not represented by counsel. No authorities were cited to support a view which would revolutionise the law relating to strikes if carried to its logical conclusion. Again, no less an authority than Sir Frederick Pollock has pointed out that the learned judge's comment on the illegality of the general strike was really extra-judicial in that it was unnecessary for him to consider the point. The fact that the defendants in the case before him were clearly acting contrary to the rules of their union was quite enough to enable him to decide the case as he did. But if we assume that the Bill appears as an Act of Parliament roundly declaring to be illegal "a strike designed or calculated to coerce the Government, or to intimidate the community or any substantial portion of the community," what will be the attitude of the country generally towards any proposal for its total repeal? Will it not be said that by repealing such a measure Parliament must impliedly declare a coercive strike to be legal? One may be permitted to wonder whether the Labour leaders considered that aspect of the matter when they declared that they would repeal the Act on the first opportunity. As for the attitude of the employers towards the measure, it would be idle to pretend that they do not support it. They have not said much in the Press or elsewhere; but it is quite plain that anything which may tend to diminish those strikes, the mere threat of which is a constant clog upon the wheels of industry, will be heartily welcomed by them.

Metallurgists and Engineers.

THE thirty-third James Forrest Lecture, delivered before the Institution of Civil Engineers by Professor Carpenter on May 3rd, is not only a valuable contribution to the history of metallurgical progress, but may be regarded as an important aid to the better mutual understanding of metallurgists and engineers. Towards that understanding THE ENGINEER has always used its best endeavours, among which the institution of the monthly metallurgical supplement, THE METALLURGIST, may perhaps be particularly mentioned. The two professions, both of world-wide and fundamental importance, are closely inter-related. The engineer is entirely dependent upon the metallurgist for his materials of construction and to a considerable extent for guidance in their best treatment and application. The metallurgist, on the other hand, is dependent on the engineer, not only for the most important markets for his products, but for all the great appliances used in metallurgical operations. The great works of the metallurgist are, in themselves, monuments of engineering achievement.

In these circumstances it is truly surprising to find how slight is the degree of mutual understanding and sympathy which exists, in many instances, between members of the two professions. The two eminent engineers who voiced the thanks of their Institution to Professor Carpenter after he had delivered his lecture, expressed their surprised delight at much of what was contained in even the brief abstract which he was able to present in a well-filled hour, and that surprise was clearly

shared by many others of the audience. It is significant of the state of affairs in this respect that twenty-one years have elapsed since a James Forrest Lecture dealing with metallurgical matters was delivered before the Institution. It is perhaps ungracious to dwell on that point when the Institution of Civil Engineers has just taken a step, so fully justified by the result, towards better mutual knowledge between the two professions, and we mention it only in the hope of securing still fuller mutual intercourse and co-operation in the future. The age of specialisation in which we live brings with it both advantages and drawbacks. In the present state of development of both science and technology, progress would obviously be impossible without intense specialisation. The literature of every branch of work is so voluminous, the number of new contributions offered so great that the specialist himself finds it difficult to keep pace with the progress of his own subject, while the specialised institutions are overwhelmed with material which they find it difficult to publish and still more difficult to discuss adequately. Were it not for the numerous specialised Institutes and societies, such publication and discussion would be entirely impossible. But specialisation of this nature leads inevitably to the serious risk that the broader view may be lost and that ideas and conclusions which would result from a wide outlook may remain undeveloped. This risk is making itself felt no less strongly in pure science than in technology, but in that field there is, fortunately, one strong central body—the Royal Society—which stands aloof from specialisation and retains as its field the progress of science as a whole. That body provides a meeting-ground for scientific workers of the highest order in all fields of "natural knowledge," and holds and fills a unique place worthy of its great history and traditions. It does not and, with limited resources, cannot hope to do all that is desirable, but at least it forms a powerful nucleus for an effort to prevent undue specialisation from severing even those working in adjacent and closely related fields. If the solution of this problem is difficult in connection with pure science, it is, if possible, even more difficult as regards technology, and there is therefore the greater need for a correlating and co-ordinating body which should serve to bridge the gulfs that are rapidly widening between men working in different branches of what may be very broadly termed "engineering." The case of the engineer and the metallurgist is perhaps the most immediately important example, but many others are to be found. Professor Carpenter's James Forrest Lecture is not only a brilliant example of what can be done by a leader of one branch of technology in rendering his subject interesting and stimulating to engineers in general, but it has also shown how much these workers in other fields appreciate such matter when it is put before them. Once in twenty years, however, is entirely inadequate, if only because it throws an undue strain on the man, however able, who is asked to give a survey of so long a period in times of rapid progress. This remark obviously does not relate to metallurgy alone, although perhaps that subject is the most important example to which it can be applied.

This work of keeping the different branches of the engineering and allied professions in regular touch with each other is not to be regarded lightly. From the point of view of the advancement of technology, of engineering, and of industry generally, it is almost, if not quite, equal in importance to any other activity that a great Institution can pursue. But its difficulties are correspondingly great. Both as regards money and organisation it imposes a heavy tax upon the body undertaking it, a tax which only a powerful Institution could bear The greatest difficulty, however, lies in finding the right men to act as exponents of their own line of work to the men of the allied professions. It is not by any means an easy matter for a metallurgist to make an account of metallurgical progress interesting to engineers. The success attained by the James Forrest lecturer of 1927 is matter for congratulation both to Professor Carpenter and to the Institution of Civil Engineers, but similar success in a series of lectures of this type on different subjects would be difficult to secure. The highly qualified specialist is not always a good lecturer nor even capable of appreciating what would and what would not appeal to an audience the members of which are not expert in his subject. A very careful choice of men and subjects would, therefore, be necessary if that method of dealing with the question were to be contemplated. But whether by lectures or otherwise, there is the greatest need for some means whereby workers in different branches of technology may be kept in touch with each other. The attainment of mutual knowledge is nine-tenths of the way to mutual understanding, and it is that which is very much needed. There is, perhaps, no better purpose to which a great Institution could devote a part of its energies and resources.

Torsional Fatigue.

AT the meeting of the Institution of Mechanical Engineers held in London on the 29th of last month, Mr. Stromeyer made the suggestive remark that the day would soon come when we should feel safer about materials subjected to varying or alternating stresses than we do about materials subjected to static stresses. At first sight Mr. Stromeyer might seem to be seeking a place among the optimists, if not the humorists, but on reflection and study of the established facts we can readily discover scientific support for his suggestion. It would appear definitely to be true that a metal behaves better under a fatigue load than under a static load just as times of emergency in the life of an individual or a nation call forth qualities of a higher quality than those normally exhibited. Clear evidence of this phenomenon in the case of metals subjected to varying shear stresses is provided in the letter from Mr. Hankins, which we publish in to-day's issue. No engineer would care to load, under static conditions, a working member of 32-ton steel much above 10 tons per square inch. Such a stress would imply a factor of safety of about 3, based on the ultimate strength, and of about 2 on the yield point. Yet a mild steel specimen having an ultimate static shear strength of 32 tons was found by Mr. Hankins to be capable of withstanding successfully ten million cycles of a range of stress having a minimum value of 10·4 tons and a maximum value of 28·8 tons per square inch. For ten million times, this material carried, momentarily, a load only 3·2 tons short of that required to break it under static conditions, a load, that is to say, which was far above the statically determined primitive yield point. Even the minimum value of the varying stress would be considered by many engineers a daring load under static conditions. Mr. Hankins tells us of another steel which remained unbroken after ten million cycles which took the loading to 44·5 tons, or 5·5 tons short of the ultimate static shear strength. Goodman's law, quoted by our correspondent, implies that any specimen will fail at once if it is subjected to a cycle of loading the maximum value of which is equal to the ultimate static strength of the metal. But Mr. Hankins' results do not confirm Goodman's law. They transcend it. His first specimen, for example, bore a varying stress, the maximum value of which was 5 tons above what it should have been according to the law. His second specimen bore a maximum stress which surpassed that prescribed by the law by nearly 8 tons. These margins are considerable. They do not exclude the possibility that the specimens would have safely withstood a varying load the maximum value of which might have been actually greater than the statically determined ultimate strength. It would appear therefore that if the load is varying a metal may be safely stressed to a point which under static loading would be rightly considered as inviting, possibly even ensuring, disaster.

Literature.

The Marketing Problem. By E. T. ELBOURNE. London: Longmans, Green and Co., Ltd. Price 10s. net.

BETWEEN the producers of goods and consumers there is a barrier which is known in America as "Sales Resistance." Mr. E. T. Elbourne has prepared an exhaustive analysis of the means adopted in America for breaking down this sales resistance. As there are similar barriers in all other countries, we are disappointed to find that the author has shown a certain lack of courage when, in his preface, he says that the book is not intended to instruct the reader nor advocate American methods. In a book so transparently useful to everyone connected with industry in any country, such a statement is not warranted.

Mr. Elbourne begins by surveying the growth of American prosperity in the form of higher production, higher real wages and higher consumption, and then proceeds to point out that the problems of buying, operating and selling are all capable of scientific analysis, the use of which is to reduce the risks of "snap" judgments. Owing to the success of scientific analysis in America, there is a growing appreciation of the value of commercial research. An account is given of the commercial researches carried out by various organisations from the United States Department of Commerce to banks. This interesting development of American banking strikes us as showing the greatest divergence between British and American banking practice. "So far as commercial research work by the banks is concerned, this appears to be of a very high order. The practice of American banks in making large loans that are relatively unsecured, except by inference from the business stability of the borrowing firm or individual, has necessitated a wider outlook than is the case where ample collateral tangible security is required. American banking has identified itself so closely with industry that it has been doing commercial research for years in the every-day course of business, without always recognising it as a separate function." If British banks went out of their way to secure the same detailed knowledge of industry, progressive businesses would find less difficulty in securing financial accommodation to meet extension—to the mutual benefit of banks and business.

The very complete organisations for the dissemination of useful trade figures in America are dealt with comprehensively. In this connection, no one would deny that similar information broadcast in England would benefit our trade, inasmuch as the forecasting of business conditions and budgeting would become more reliable.

The price of goods to the consumer is made up of the cost of production and the cost of selling. On the average at least one-third of the price the consumer pays is the cost of marketing. Great strides have been made by engineers in mastering the management of production, but, until comparatively recent times, nothing had been done to reduce the cost of distribution. Now, however, "the engineering mind is extending its field of operation to include marketing." In this direction, the work of Mr. Hoover, who, incidentally, is an engineer, has met with phenomenal success. Mr. Hoover has already set 100 industries proceeding with definite programmes for eliminating waste by co-operative effort. In the words of Mr. Hoover, this is "not waste in the sense of wilful waste, but the economic waste which is the natural outcome of the competitive system. It is not the waste any single individual can correct by his own initiative, but waste which can only be remedied by collective action." From the examples cited of the savings already effected, we would mention the fact that 200 industries have already adopted a uniform system of cost accounting. In Great Britain the only organisation tackling this problem is the British Engineering Standards Association, which has amply justified its existence. We would like to see other trades set up similar bodies.

The comparative usefulness of the various methods of advertising are analytically dealt with at some length. This section of the book should prove invaluable for reference. An interesting new departure in the arrangements between firms and advertising agents—already meeting with success—is recorded by Mr. Elbourne. Under this arrangement the services of an advertising agent to a client are rated on a flat fee basis. "If the commissions received from the publishers do not meet the fees chargeable, the client undertakes to make payment accordingly. Up to a point this makes the agent's remunerations independent of the volume of advertising recommended."

Marketing surveys and analyses are carried out by newspapers and trade journals in great detail. One such analysis brought to light the useful fact that "superintendents and works managers are the leading buying influence for industrial equipment. General managers are next; then the chief engineers and engineering departments."

We are glad to see that Mr. Elbourne draws attention to the fact that at last Americans have discovered that "high-pressure" selling does not pay. Sales resulting from "hypnotising the victim into signing a firm order are found to be limited to first sales. It causes a reaction which makes repeat orders or another interview improbable" for the same reason that it does not pay to advertise an inferior article.

In collecting this information and publishing it in a compact form, Mr. Elbourne has done a useful service, and we have no hesitation in commending his book to those of our readers whose business it is to secure more customers in the most economical way.

BOOKS RECEIVED.

Oil and Retortable Materials. By G. W. Halse. London: Charles Griffin and Co., Ltd., 42, Drury-lane, W.C. 2. Price 7s. 6d. net.

Ordinary Differential Equations. By E. L. Ince. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 36s. net.

Der elastisch drehbar gestützte Durchlaufbalken. By Dr.-Ing. H. Craemer. Berlin: Julius Springer, Linkstrasse 23, W. 9, Germany. Price 5·10 marks.

Water Transport: II., Merchant Steamers. Catalogue of the Collections in the Science Museum. Compiled by G. S. Laird Clowes. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. 3d. net.

Gas Storage of Fruit, by Franklin Kidd, D.Sc., Cyril West, D.Sc., and M. N. Kidd, M.A., being Food Investigation, Special Report No. 30, of the Department of Scientific and Industrial Research. London: H.M. Stationery Office. 1s. 9d. net. 1927.

The Growth of Crystals in Supersaturated Liquids.*

AT the Institution of Mechanical Engineers on Wednesday, May 11th, Sir Henry A. Miers, F.R.S., delivered the Seventeenth May Lecture to the Institute of Metals, taking as his subject "The Growth of Crystals in Supersaturated Liquids." Dr. Walter Rosenhain, F.R.S., presided in the absence of the President, Sir John Dewrance.

Sir Henry Miers said that he had been surprised and honoured at receiving the invitation to deliver the May Lecture, and it was only after the invitation had been received that he realised that some experiments made by himself and some of his pupils at Oxford twenty years ago were of any interest to metallurgists. That, perhaps, indicated how entirely out of touch with scientific work he had been during those twenty years. Therefore, he proposed to give some account of these experiments and to mention some instances of their application. The growth of crystals was not really the subject he had started out to investigate; he had been endeavouring to measure the angles of crystals whilst they were growing in their solutions, and for that purpose he was trying to ascertain the concentration of the solution in contact with the crystal.

Showing some slides of the apparatus used, Sir Henry explained that by using the crystal itself he had been able to measure the angle of total internal reflection of light that was transmitted into the crystal and reflected out again at the surface. With the apparatus he was able to immerse a crystal in a solution and measure the refractive index of the liquid in contact with it, and by using a glass prism, to make a large number of observations of solutions of known strength and discover for each temperature what was the concentration of the solution corresponding to a given refractive index. In that way he had been able to ascertain the actual refractive indices and the actual concentrations of the liquid in contact with the growing face.

One curious result shown by those experiments was that, as the cooling solution was examined, it was found that the refractive index increased steadily until, without any outward and visible sign, it suddenly, at a certain temperature, reached a maximum and then began to diminish. In the case of sodium nitrates, the refractive index increased until the temperature was 36½ deg. and then began to diminish. When the solution was at rest there was no outward sign accompanying this diminution of the refractive index, but when the solution was stirred it was found that a fine shower of crystals came down at that temperature, at the same time as the sudden change in refractive index. Therefore, the change in index was clearly due to the relief of super-saturation by a sudden growth of crystals, and a break in the curve indicated the point at which crystals began to grow. That led him to suppose that the change in index was entirely due to the rapidly increased growth of crystals in the solution, either from crystals which were already there or from crystals which first made their appearance in that way. He was led to that conclusion because often, on the first day of the experiments, no crystals appeared, and there was no break in the curve until it reached a maximum, but on the second day the crystals appeared at the lower temperature, clearly indicating that there were probably crystal germs in the atmosphere of the laboratory which produced growth of small crystals at a higher temperature before the maximum was reached. That seemed to fit in with Ostwald's suggestion that the higher temperature was that at which a solution was saturated, whilst the lower temperature and the higher refractive index corresponded to the point at which spontaneous crystallisation began. Therefore, he naturally interpreted those experiments as indicating the temperatures in a given solution at which spontaneous crystallisation took place.

A large number of solutions were treated in that way, and the results, which all pointed to the same conclusion, gave an indication of the temperatures at which spontaneous crystallisation took place after cooling super-saturated solutions. It then occurred to him that the refractive index at the saturation point, determined for a number of solutions of different strengths, would enable a curve of the solubility at the freezing point or temperature of crystallisation to be drawn. Therefore, a new curve was drawn to which he had given the name of the super-solubility curve, *i.e.*, a curve of temperatures at which spontaneous crystallisation took place. Examples of such curves were shown, ten different solutions of varying strengths having been experimented with. In each of these experiments, the results represented the effects of the cooling on a stirred solution which was kept, as far as possible, free from inoculation from without, and the curves indicated that each solution cooled down with a considerable degree of super cooling until a shower of crystals came down.

All the experiments were confirmed in two different ways. In the first place, solutions of certain strengths, as shown on the curves, were placed in sealed glass tubes and vigorously shaken, and in all cases no crystallisation took place in the sealed glass tube until the temperature represented by the solubility curve was reached, when a cloud of crystals came down. These results were again confirmed by examining the cooled liquid and placing in it minute fragments of crystal. As the solution cooled, one fragment after another was immersed until the solubility curve was reached, and the minute crystal dissolved. When the saturation point was increased, the minute crystal neither grew nor dissolved, but at lower temperatures, corresponding to the temperatures given by the experiments, a cloud of crystals was produced in the neighbourhood of those minute crystals which must grow rapidly. Therefore, although the interpretation of the results was that there was, for each solution on cooling, a certain temperature at which a largely increased rate of crystallisation took place, the results could only be determined as meaning that spontaneous crystallisation took place at that point and not before. Among the substances which were investigated in that way were sodium nitrate, sodium chlorate, a mixture of salol and betol, a mixture of naphthalene and beta-naphthol and monochloracetic acid, and in every case the two methods mentioned were adopted in order to confirm the original conclusion.

This work came to an end partly because he left Oxford and became the Principal of the University of London, and he had to give up experimental scientific work. Some time afterwards the experiments were continued by Mr. Harold Hartley and some of his pupils by enclosing solutions in sealed glass tubes and shaking them, and the same phenomenon that he himself had observed was encountered with sodium sulphate, sodium sulphite, and other solutions. There had also been a certain amount of investigation on similar lines by a few other workers, and the conclusion arrived at was that, for all the mixtures investigated, there was, at a certain temperature, a sudden and violently increased rate of crystal growth, and in the absence of inoculation or crystal germs in the liquid there should be spontaneous crystallisation.

One obvious method of confirming these experiments was to scratch the side of a vessel containing the solution and see the crystals grow on the line of the scratch. It was only when the temperature fell into what he called the "labile" state—in which crystals might appear spontaneously—that the scratch of a glass rod produced a line of crystals along the line of the scratch. If the rod was introduced from outside the vessel there would very likely be not only crystal growth along the line of the scratch, but also growth due to inoculation. In short, the view arrived at as the result of these early experiments by himself and Miss Isaac, and confirmed by later workers to some extent, was that, when a solution was cooled below its saturation temperature, it passed into a "metastable" state in which crystals could only be produced by introducing a fragment of the dissolved substance, or of one isomorphous with it, and that at a lower temperature it passed into a "labile" state in which crystals might appear spontaneously. Later investigations had shown that in the metastable state, crystallisation could also be produced by shock. He believed that those experiments recorded the normal behaviour of crystallising liquids and that crystallisation only took place with some degree of supersaturation or undercooling. In his experiments there was always a sudden outburst of crystals at a definite temperature.

Since the experiments were carried out, it had been made manifest that geologists attached little, or indeed hardly any, importance to undercooling in their speculations concerning the crystallisation of molten magmas; neither had the experiments been received with great favour by physicists and chemists. He was bound to say, however, that those early experiments, to which he had referred, had found much more favour with metallurgists than anybody else, and papers by Huntington and Desch, Portevin, Gwyer and Phillips, S. W. J. Smith, and Hanson and Gayler were mentioned in that connection, all of which in some measure applied the conclusion arrived at as the result of his own early work. At the same time, Sir Henry said that he wished to make it clear that his own observations were made on aqueous solutions or on mixtures of comparatively low viscosity, and that they related to changes from liquids to solids. The result of that work convinced him at the time that a certain amount of undercooling was necessary before any appreciable growth of crystals took place.

It had often been pointed out that there was no known limit to the time during which some undercooled liquids and solids could exist without change, and he was able to mention an interesting example. He had with him a tube of salol solution which he sealed eighteen years ago. That tube had been shaken constantly and had been subjected to all kinds of changes of temperature, and had travelled in goods trains from Manchester to Oxford and from Oxford to London, and it had still remained liquid under those varying conditions. But a remarkable thing had taken place. After declining to crystallise for eighteen years, it had actually crystallised two days before he gave the present lecture, quite suddenly, and without showing any signs of doing so even two minutes before. He would very much like to know the reason why that particular date should have been chosen by the tube of salol to crystallise. He could only imagine that it was shy of appearing in the liquid state before the Institute of Metals! It was an interesting point, because the tube had not been shaken and the room temperature was about 20 deg. Salol had a melting point of 42 deg., and became labile when exposed at 33 deg. That particular sample had been far below the labile temperature all its life.

Whilst he had been concerned in this lecture with the importance of undercooling and super-saturation, in the actual beginnings of crystal growth, Sir Henry Miers said that it was not the subject he had originally embarked upon. He was really engaged in the far more interesting question to himself of the manner in which crystals grew when once they had started, and it was in following up that question that he came across the interesting question of the nature of the solutions. For that reason he had not said anything about the vast amount of work that had been carried out on the manner of the growth of crystals in their solutions. Until we knew more about the conditions which prevailed at the surface of a crystal, it would be very hard to understand what was the relationship between the way in which crystals began in a solution without visible crystalline material, and the way in which they grew in contact with the already existing crystal. We wanted more information of the physical nature of the under-cooled liquid or vapour in which the growth took place. Perhaps some light could be thrown on that by X-ray examination of crystal nuclei before they became visible to the naked eye.

*Seventeenth May lecture to the Institute of Metals, delivered May 11th, 1927, by Sir Henry A. Miers, F.R.S. Abridged.

SIXTY YEARS AGO.

IN the spring of 1867 war was muttering in the air all over Europe. Signs of the coming storm were patent to all observers, and found a reflection even in our own columns. Outwardly the nations had met in friendly rivalry at the great exhibition which the Emperor of the French had staged in the Champ de Mars, but beneath the surface portents and signs of the trouble that was brewing and that came to a head three years later could be detected. Prussia dreamed of a united Germany, and flushed with her recent triumphs over the Danes and the Austrians, almost seems to have gone out of her way at the Exhibition to declare allegorically her intentions towards France. For the decoration of her section she had chosen a scheme involving banners of the black and white Prussian colours mounted on spears with gilded heads, a spade or fork or other agricultural implement being placed between each pair of spears. At the centre there were heads of horses "with erect ears and starting eyes as if smelling the battle afar off," and on either side there were heads of oxen taken as intended to represent "food for the sinews of war." "The combinations," wrote our Commissioner at the Exhibition, "can scarce be accidental, and, if otherwise, are scarcely gracious on the part of invited guests of France." But Prussia, he added, with her many greatnesses and noble virtues had learned insolence of late years, under the ill but able teaching of those who ruled her. Signs to the same end were discovered in the fact that this country was alone in exhibiting a representative selection of up-to-date military weapons. All the other military Powers had promised to stage a corresponding exhibit, and we had submitted ours on the understanding that they would do likewise. We were disappointed of that hope, and had to lament that while other nations had been given every facility to inspect the details of our very latest pattern of guns and ammunition, they were united in withholding all exhibits illustrating or bearing upon their own activities in that direction. It was a period of intense development of fire-arms. To meet the Prussian needle gun, the supreme value of which against muzzle-loaders had been fully demonstrated in the campaign against Austria in 1866, the French were developing the Chassepot rifle. In our issue of May 10th, 1867, a note appeared which reveals perhaps more clearly than anything else could have done the anticipations moving through men's minds at the time. The Chassepot rifle had been tested before the Emperor. A battalion of 500 men had in two minutes fired 8000 balls at a range of 600 yards, and of the shots 1992 had struck the line of aim. The ground in front of the mark was so cut up that not a blade of grass could be seen. "It is frightful! It is a massacre," the Emperor declared, and no doubt was felt that in his mind's eye he saw 500 Prussians standing where the grass had been.

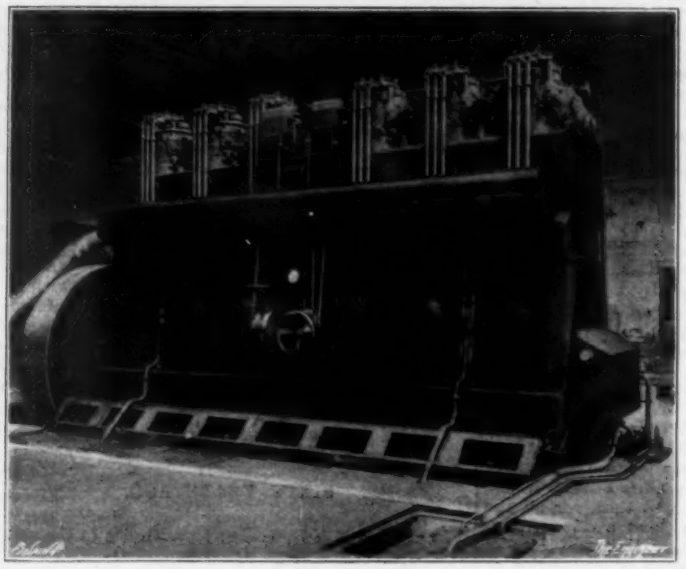
CYLINDER PIERS FOR DOCKYARD WHARF.

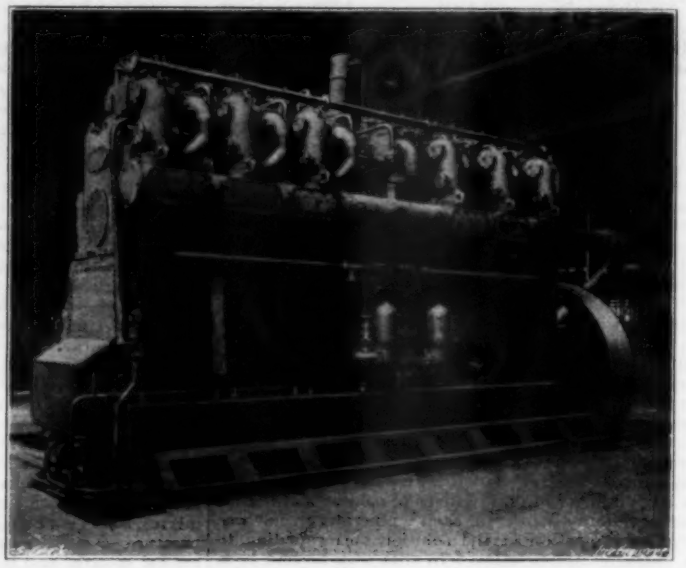
IN the construction of a new fitting-out wharf at the Bremerton naval dockyard, concrete cylinder piers were adopted instead of concrete piles, owing to the great depth of water and the soft soil. For this work the cylinders were precast, using quick-hardening alumina cement, and after being sunk in place they were filled with Portland cement concrete. These cylinders were 4½ft. in external diameter, with walls 6in. thick, but at the bottom they flared out in conical form to give a base 15½ft. in diameter. Their lengths ranged from 25ft. to 60ft. They were cast in vertical forms or moulds of steel plate, made up in sections. When cured, the cylinders were handled by a large floating derrick, which dropped them in position. They were then sunk to the required depth by the pneumatic system, the bottom "bell" of the cylinder forming the working chamber, and the shaft being surmounted by an air lock and concrete lock. After many experiments with the high-alumina quick-setting cement, a concrete of 1 : 2 : 2½ proportions was used, with a mixing period of 1½ minutes. For the core or filling the ordinary concrete was proportioned 1 : 1½ : 3.

A 1000 B.H.P. Airless Injection Marine Oil Engine.

No. I.

A MARKED trend of development in recent oil engine practice, both at home and abroad, has been the increasing use of direct fuel injection methods, in which the necessity for an air compressor is entirely done away with. Among engines of this type, built on the Continent, an outstanding example of a modern four-stroke cycle motor working on the airless injection principle is the "V.M." type Deutz oil engine. In the present article it is proposed to describe and illustrate the main features of this engine, while in a second article we shall give an account of comprehensive tests which were made on the first six-cylinder engine of this kind at the works of the Motorenfabrik Deutz, A.G., Köln-Deutz, towards the close of last year, by Professor P.Langer, of the Technical High School at Aix-la-Chapelle.





FIGS. 1 AND 2—FRONT AND BACK VIEWS OF DEUTZ 1000 B.H.P. MARINE OIL ENGINE

THE NEW DESIGN.

The new Deutz airless injection four-stroke cycle marine oil engine, which we illustrate herewith, is the largest of its class yet constructed, and is designed for a full load output of 1000 B.H.P. when running at the moderate speed of 215 r.p.m. Each of the cylinders has a bore of 460 mm., with a stroke of 740 mm. The particular engine we are dealing with is to be installed in a 200ft. motor cargo vessel constructed for a speed of 9 knots, which is being built for Hamburg owners. Work is, however, shortly to be begun on two eight-cylinder engines of the same pattern, each of which, we learn, will have a designed output of 1350 B.H.P. at approximately the same speed as the engine above mentioned. These engines are for two 700 gross ton motor vessels recently ordered by the Russian Government for passenger and cargo service on the Black Sea.

Before dealing with the engine details, some of the more interesting of the general features of the design may be referred to. The design is one which can be employed equally well either for land or marine work, and in order to meet the requirements of these two purposes, the engine can be fitted with a governor giving automatic speed control, or it may be built as a reversible engine equipped with hand-operated speed-regulating gear. As will be seen from Figs. 1 and 2, which show the front and the back of the engine respectively, the six cylinders are divided into two groups of three, which have a common bed-plate and cylinder jacket casting. An interesting departure from usual practice is the provision of two coupling flanges, one at each end of the crank shaft. One of these flanges is enclosed by an end casing built on to the crank chamber. This arrangement is one which assists serial manufacture by doing away with the necessity for right-handed and left-handed engines. Referring to Fig. 1, it will be seen that the starting controls, with which we shall deal later, are grouped at the centre of the engine. They are so designed that the control levers for each of the two groups of three cylinders may be worked separately or together as required. Directly above the starting controls is the enclosed casing which runs along the front of the engine about half engine height, and carries within it the cam shaft and the reversing and manœuvring shafts. The cam shaft is driven from the main crank shaft through spur gearing.

The three valves in each cylinder cover which comprise the starting valve, the air inlet, and the exhaust valve, are operated by push rods and levers in the usual manner. The two fuel pumps and the governor are placed between the two groups of three cylinders, at the centre of the engine above the cam shaft. Another interesting feature of the design is the arrangement of the air intake pipes, which, as shown in Fig. 2, connect the inlet passages in the cylinder covers to the spaces within the top cylinder casing, which surrounds the water-jacketed liners, as shown in the sectional drawing, Fig. 3. At either end of the engine, these upper casings are fitted with perforated covers, which admit air to the internal spaces, from which the inlet valves draw their supply. The working stresses of the engine are taken by stout bolts, which pass down from the top of the cylinder casing through the engine to the underside of the bed-plate. It will be seen that inspection doors are provided in the crank and cylinder casings, also the cylinder covers, so that access is readily given to the crank pits and also to the air and water jacket spaces.

Again referring to Fig. 2, it will be seen that the cooling water and bilge pumps are mounted at the back of the engine just above bed-plate level. They are worked by links which obtain their motion from excentrics on the crank shaft. The links also serve to drive the sight feed lubricating oil pumps which are placed immediately above the water pumps. The water-cooled parts of the engine include the cylinder covers, the cylinder jackets and the exhaust valves and manifolds. The latter are clearly shown in Figs. 2 and 3. In the last-named drawing, the general arrangement of the valves and valve gear and also the design of the reciprocating parts is illustrated. We may remark upon the deeply hollowed piston head giving a large combustion space of concave form. It is worthy of note that although horse-powers up to more than 160 B.H.P. per cylinder have to be dealt with, an uncooled trunk type of piston is employed. Special arrangements, we may say, are provided for quickly dismantling the pistons and connecting-rods by means of a lifting stirrup and a special support, which is inserted into the crank chamber through one of the inspection doors.

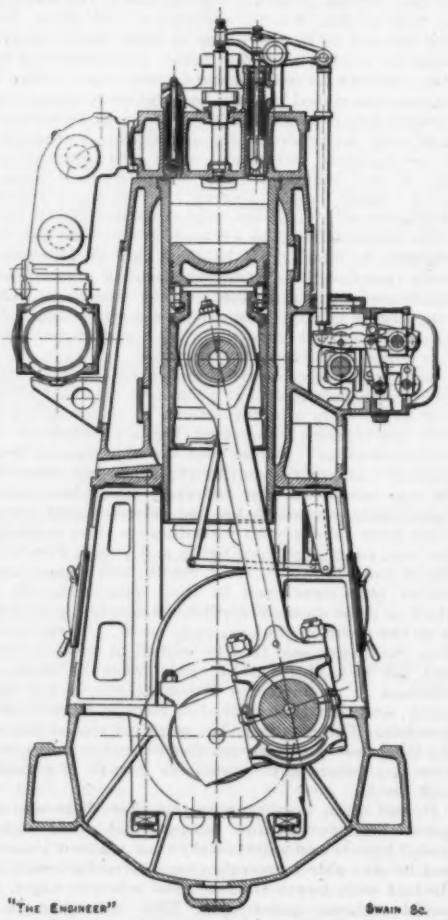


FIG. 3—SECTION THROUGH ENGINE

VALVES, FUEL PUMP AND CONTROLS.

The fuel valve is of the closed type, which is not mechanically operated, but is opened by the pressure of the fuel oil. The pressure, we understand, is about 5000 lb. per square inch. The fuel enters the combustion space through four holes, each of 0·6 mm. diameter, which are bored in the spray nozzle at an angle of 55 deg. to the cylinder axis. As evidence of the constant character of the fuel projection we may state that after making the trials, which will be referred to later, a careful examination of the faint marks on the hollow surface of the piston head in the line of the fuel spray jets showed that the direction of the jets had not altered either during the trials themselves or during the preliminary runs which were made on several days before the actual tests were begun.

The design of the fuel pumps can be studied from the sections we reproduce in Fig. 4. As already mentioned, there are two pumps on the engine, each of which has three cylinders and plungers, which are mounted in a single block with the necessary operating and control devices. The plunger axis is directly in line with the centre of the cam shaft, so that a straight thrust is obtained. The general principle of control adopted is that of determining the exact amount of fuel which is delivered to each cylinder by an earlier or later opening of the by-pass or spill valve which is operated by the governor. The by-pass valve is immediately above the plunger, and at the back of this valve is the double-seated delivery valve and suction valve, with the fuel connection below it. Parallel to the main plunger at the front of the pump is the rod which controls the lift of the by-pass valve. There are two ways of shutting off supply of fuel to the engine; it may be done either by turning the small rotary valve *a* which cuts off the supply of fuel to the pump, or by rotating the excentric pin *b*, which lifts the by-pass valve and so prevents any oil being delivered to the engine cylinders. This latter arrangement, which is practically a short-circuiting device, is only fitted on marine engines. It enables a given cylinder to be cut out in such a way that no oil can possibly reach the spray valve. It will be seen that if the supply to the pump was cut off by using the rotary valve *a* only, there would still be a possibility of oil finding its way to the spray valve, and possibly entering the cylinder, if that valve was not quite tight on its seat. The other controls are worked by the excentric pins *c* and *d* respectively, which provide means of varying the amount of oil delivered to the cylinder by the earlier or later opening of the by-pass valve, and also of timing the point of fuel injection by shortening or lengthening the lift of the rod which works the by-pass valve.

Some reference may be made to the very simple and convenient arrangement of the starting and the manœuvring controls, which are shown in Figs. 1 and 5. As will be seen from the latter illustration, they consist of a large reversing hand wheel to the right of the starting position, and on the left two

levers working in a quadrant, which are employed for the starting and manœuvring operations.

Dealing first with the reversing operation, by partially rotating the hand wheel, the levers which support the push rods operating the valves are lifted out of contact with the inlet and exhaust cams, by means of short cranks on the reversing shaft. This shaft is the front shaft at the top of the enclosed casing shown to the right of the engine section, Fig. 3. Immediately below it is another shaft, which, by means of link gear, lifts the starting cam rollers from their cams and again brings them into contact after the cam shaft has been moved in a fore-and-aft direction by means of a slotted link and the astern running cams are in position. The operations above described are automatically carried out by continued

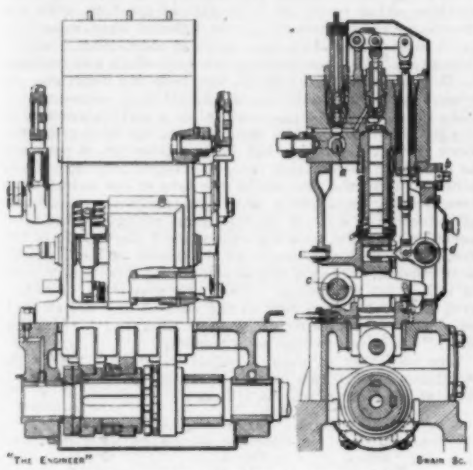


FIG. 4—SECTIONS THROUGH FUEL PUMP

rotation of the hand wheel to which we have referred.

The two levers in the quadrant to the left of the reversing hand wheel are shown in Fig. 5 at the top or running position. Each lever is provided at its extremity with a projecting handle furnished with a locking grip which controls a pawl engaging with a toothed quadrant. The left-hand handle controls the first three cylinders of the engine, while that to the right operates the remaining three cylinders. The two levers are so designed that they can be moved either separately or simultaneously, a connecting link which may be disengaged by a press stud fitted in the end of the right-hand handle being provided. The starting position is at the bottom of the quadrant, the centre position being the stop position, and the top of the quadrant corresponding to the running position as above mentioned. Assuming the levers

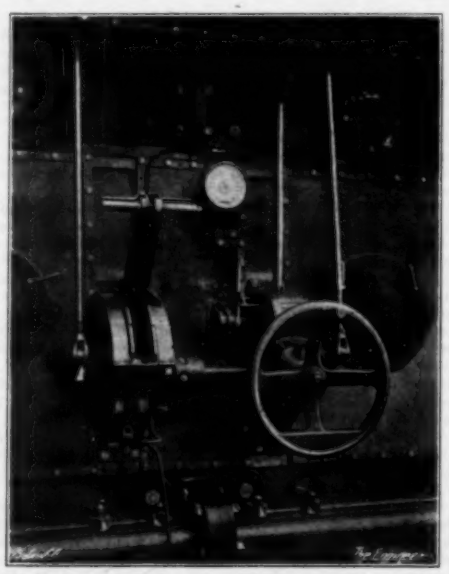


FIG. 5—STARTING AND REVERSING CONTROLS

to be in the centre position, they are pulled forward to the extreme end of the quadrant, at which position they open a pilot air valve which admits starting air to the valves on the main cylinders. After the engine has run a few revolutions the levers are carried forward through the centre stop position at which the supply of air is automatically cut off and the fuel pumps are brought into operation. Positions in the upper part of the quadrant correspond to settings delivering varying amounts of fuel to the cylinders. By freeing the two levers by disengaging the locking pin, three cylinders may be run for a short time on compressed air, while the others are working on fuel. Means are thus provided for dealing with every probable starting condition. We understand that the complete reversing operation is carried out in from eight to ten seconds, starting air at a pressure of from 350 lb. to 400 lb. per square inch being employed.

The engine we have described, while robustly built, is comparatively light in weight, its total weight being 55 tons, which, with the rating of 1000 B.H.P., works out at a little under 125 lb. per B.H.P. hour. In the following article we shall give an account of the performance of the engine on different loads, and when working with early and normal fuel injections, together with the test curves and comparative results which have been obtained by Professor Langer.

(To be continued.)

Central Scotland Electricity Scheme.

SINCE the passing of the Electricity (Supply) Act, 1926, the Electricity Commissioners have been engaged upon the preparation of various schemes, and the first, which relates to Central Scotland, has now been transmitted to the Board, which, after certain preliminaries designed to give all parties interested an opportunity of making representations, will apparently adopt it with or without modification, and will ultimately put it into operation. The area involved is about 4980 square miles, including, roughly, the whole of the industrial, shipbuilding and coalfield areas of Scotland, and extending from Montrose and Brechin in the county of Forfar to the southern boundary of the County of AYR. At present there are forty-two authorised undertakings in the area owning between them thirty-six generating stations, but under the proposals of the scheme only ten of the existing stations will be selected and operated for the Board, and at a later date the requirements of the Board can be met by six out of these ten stations.

The scheme also contemplates the extension of four stations between 1932 and 1938, and the erection of two new stations, each of not less than 100,000 kilowatts by 1938. Broadly, it is expected that in ten years time the area will be supplied by eight capital stations, six of which are already in existence and the remaining two will be new. These stations are to be interconnected by a series of high-pressure main transmission lines, and the system is to be designed in the form of a series of ring mains, so that there will be alternative routes to points of supply, and consequently the possibility of breakdown will be materially reduced. Incidentally it is estimated that the interconnection of the stations will release for revenue-earning purposes about 88,000 kilowatts of plant which now serves as spare plant and which represents a sum of about £1,670,000.

With the publication dealing with the scheme the Commissioners have issued a second publication giving supplementary particulars, in which they have outlined a plan of working the selected stations with the necessary estimates. Since the practical working of the scheme, including the fixing of tariffs, is the responsibility of the Board, these suggestions are, of course, tentative, but it is noteworthy that the Commissioners contemplate that the Board should be able to commence supplying in August, 1929, and it is estimated that in four years 1930–1934 there will be a gross saving to the undertakers within the area of no less than £894,000, or an average of nearly one-quarter of a million per annum. The full benefits to the consumer in the shape of reduced prices can, however, only be realised as the progressive economies take effect. The capital already spent on the thirty stations that are to be shut down must be paid off or discharged, and it is only when this has been done that the full advantages of the new scheme will be experienced.

Unfortunately, the scheme involves changing the frequency of eleven supply undertakings and five generating stations from 25 to 50 cycles, for comprehensive regional schemes cannot be carried out with full economy in areas where there are different systems of supply, and the Commissioners have therefore given early attention to the industrial areas in which a non-standard frequency has been widely adopted. The object, it is stated, is to avoid future expense on non-standard plant, and to hasten the time when manufacturers, as well as undertakers and consequently consumers, will obtain the benefits arising out of the production of electrical machinery for one uniform frequency.

The stations that have been selected for use under the scheme are the Clyde's Mill and Yoker Stations, belonging to the Clyde Valley Electrical Power Company; the Dalmarnock Station, belonging to the Glasgow Corporation; the Stonebyres and Corra Linn Stations of the Lanarkshire Hydro-electric Power Company; the Portobello Station of the Corporation of Edinburgh; the Bonnybridge Station of the Scottish Central Electric Power Company; the Carolina Port Station of the Dundee Corporation; the Dunfermline Station of the Fife Electrical Power Company, and the Kilmarnock Station of the Ayrshire Electricity Board. It is expected, however, that the last four stations will only be required for limited periods. A new station in the west of the area, designated Station A, is to be designed as an eventual capital station, the first section comprising an installation of not less than 100,000 kilowatts of plant, and it is estimated that the first section will be required for operation by the winter of 1937-38. The other new station in the east of the area, designated Station B, would also have an initial capacity of not less than 100,000 kilowatts, and subject to the contingency that the necessity for the station or the date of commencement of construction may be affected by arrangements which may be made by the Central Electricity Board for obtaining supplies for the eastern district from other sources, this station will also be required for operation by the winter of 1937-38. Under the scheme certain extensions and alterations are to be made to the existing selected stations.

For the interconnection of the selected stations with one another and with the systems of authorised undertakers the following three-phase lines operating at a pressure of 132,000 volts between phases and capable in each case of transmitting not less than 50,000 kilowatts are proposed:—(*a*) Clyde's Mill to Yoker *viâ* Dalmarnock and Port Dundas; (*b*) Portobello to Dalmarnock *viâ* Dunfermline and Bonnybridge; (*c*) Portobello to Clyde's Mill *viâ* Motherwell; (*d*) Dalmarnock to Greenock direct; (*e*) Dunfermline to Dundee *viâ* Kirkcaldy; and (*f*) Yoker to Greenock *viâ* Paisley, Kilmarnock and Saltcoats. The estimated dates of completion of these lines are October 31st, 1928; October 31st, 1929; October 31st, 1930; October 31st, 1931; October 31st, 1931; and October 31st, 1932 respectively. In connection with these inter-connecting lines, transforming stations would be provided. Two three-phase, 11,000-volt, single-circuit main transmission lines from Corra Linn to Stonebyres and two double-circuit three-phase lines working at the same pressure from Stonebyres to Motherwell would be acquired by the Board. Temporary arrangements for the purposes of the scheme will, if deemed necessary by the Central Electricity Board, be entered into between the Board and owners of certain generating stations specified in the fifth appendix to the publication dealing with the scheme.

The other publication giving supplementary particulars contains a mass of information, but we need only refer to one or two outstanding points. The cost of the primary transmission system and the transforming stations is estimated at £2,204,034, allowing for the capitalisation of interest during the first five years, whilst the approximate net cost of standardising the frequency if commenced in January, 1928, is given as £2,921,250. On the basis of interest at 5 per cent. and a forty-year sinking fund computed on a 3½ per cent. table, the annual capital charges would amount to £181,000. It is estimated that by the end of the financial year 1933–34 the capital expended under the scheme by the Central Board on transmission and standardisation of frequency and by the owners of selected stations on alterations and extensions thereto will have been as follows:—

By the Central Board—	
Transmission lines and transforming stations (including capitalised interest)	£2,204,034
Standardisation of frequency	2,921,250
	5,125 284
By owners of selected stations (56,250 kilowatts)	850,000
Total expenditure	£5,975,284

On the basis of individual development in the absence of the scheme, it is estimated that the authorised undertakers in the Central Scotland area would have to make provision by 1933–34 for the installation in existing or new stations of additional generating plant amounting to 250,400 kilowatts (exclusive of that mentioned above) to meet the load in that year, representing a capital expenditure of £3,312,320. Although the cost of standardisation necessarily appears as part of the capital outlay needed by the scheme, the resulting annual charges thereon will not fall wholly upon the undertakers in the area, and when allowance is made for this fact it appears that the system of interconnection for the Central Scotland area, providing greatly improved facilities for subsequent developments, can be effected by a capital expenditure not greater than that which would have to be incurred by the authorised undertakers concerned on individual extensions in the absence of any scheme. If carried beyond the period under review, the Commissioners go on to state, the comparison would show progressive savings on capital under the scheme as contrasted with individual development, while on completion of the scheme a proportion of the existing spare plant in selected stations will have been released for revenue-earning purposes, such released plant amounting in all to 87,890 kilowatts and representing an actual expenditure of £1,670,000. Additional advantages, it is stated, will also accrue by reasons of reductions in the cost of generation and from savings in expenditure which would otherwise have been necessary on secondary transmission lines by individual undertakers.

The Commissioners have assumed that the expenses of the Central Board (other than those incurred in the generation or purchase of electricity) would be averaged over a period of years and their estimates included in the supplementary particulars have been prepared on the basis of a uniform average charge by the Board of 0·0475d. per unit for such expenses from the commencement of the supply by the Board and throughout the period covered by the tables in the publication. It is shown that by making such a charge from the outset the Board would be enabled

to carry forward and accumulate a surplus balance in the years before the capital charges on the transmission line came into account and that such accumulated balance would meet the deficit in 1933–34 and years immediately following until a position of stability is attained.

Interactions of Gases and Ore in the Blast-furnace.*

By WILLIAM A. BONE, D.Sc., F.R.S.; L. REEVE, Ph.D.; and H. L. SAUNDERS, Ph.D.

In the "Report on Fuel Economy and Consumptions in the Manufacture of Iron and Steel," presented to this Institute in 1919 on behalf of the British Association Fuel Economy Committee by Professor W. A. Bone, Sir Robert Hadfield, and Mr. A. Hutchinson, a review was made of the classical researches of the late Sir Lowthian Bell more than fifty years ago into the chemical phenomena of iron smelting, and the conclusions drawn therefrom as to the limits of fuel economy in a blast-furnace smelting calcined Cleveland ironstone. The opinion was expressed that "the fuel situation has now become so serious in this country that the industry ought to set aside sectional and individual interests and jealousies in a mighty and patriotic concerted effort to achieve the utmost economy in its use of coal. . . ."

This appeal was not altogether in vain, for in the year 1923 the National Federation of Iron and Steel Manufacturers set up a Fuel Economy Committee for the purpose of organising co-operative investigations and researches into such matters, and although much remains to be done in developing and extending the work, a serious start with the problem has been made.

At one of the early meetings of the Committee, the question was raised whether the conclusions arrived at fifty years ago by Sir Lowthian Bell regarding limits of fuel economy in the blast-furnace, which until recently had been generally accepted, were really as unquestionable as had been supposed. One of the authors of the present paper pointed out that very little systematic fundamental research upon blast-furnace reactions had been done since Bell published his treatise on "The Chemical Phenomena of Iron Smelting" in the year 1872, and expressed the opinion that "the time is undoubtedly ripe for a systematic reinvestigation of the whole matter in the light of the new scientific knowledge which has accrued during the past fifty years, and the newer methods which are now available." Not only is our present knowledge of the factors governing the interactions of solids and gases, though still imperfect, much better than it was then, but the methods and instruments now at our disposal for investigating such matters are more refined than those of fifty years ago.

The Committee, having unanimously endorsed this opinion, resolved to give immediate effect to it by arranging for such a systematic reinvestigation of the subject to be undertaken under its auspices. Arrangements were made for the research to be carried out under Professor Bone's supervision in the Fuel Research Laboratories in the Department of Chemical Technology, at the Imperial College of Science and Technology, London. This paper embodies the principal results of the first two years' work upon the interactions of the furnace gases and ores at temperatures up to 650 deg. Cent.

Sir Lowthian Bell's Researches and Theories.

It was about the year 1868 that Sir Lowthian Bell began his classical investigations upon the chemical reactions and limits of fuel economy in the blast-furnace, the results of which were embodied in his "Chemical Phenomena of Iron Smelting," published four years later. He was acquainted with the fact that, if all the reducing energy of the carbon monoxide could be utilised, the amount of coke necessary for the complete deoxidation of iron oxide and the impregnation of the metal was only about 6½ cwt. per ton. On the other hand, he had estimated that the minimum thermal requirements of the furnace, when charged with calcined Cleveland stone yielding 40 per cent. of pig iron and requiring about 11 cwt. of limestone per ton of metal, amounted to approximately 80,000 (cwt.-deg. Cent.) heat units per ton. This estimate did not include the sensible heat carried off in the exit gases, this quantity depending upon their volume and temperature. Assuming that the latter could be reduced to a minimum of 275 deg. Cent., and further that the CO/CO_2 ratio in the escaping gases could be reduced to 2·0, he showed that the above heat requirement would be satisfied by a fuel consumption of about 21 cwt. of coke (92½ per cent. carbon) per ton of metal, with blast heated to 500 deg. Cent. This he regarded therefore as the minimum practical fuel consumption per ton of pig produced from Cleveland stone under the conditions stated.

Actually in the early 'sixties 29 cwt. of coke per ton of iron were being consumed in the Clarence furnaces of Bell Brothers. This consumption speedily fell to 23 cwt. per ton of iron in 1865, when two new furnaces were blown in. In view of the new regenerative hot blast stoves introduced by Thomas Whitwell and E. A. Cowper during 1860–65, Cleveland ironmasters were everywhere building larger furnaces and using hotter blast, confidently anticipating that each increase in furnace dimension or blast temperature would result in a reduction of the coke consumption. In 1868 two gigantic furnaces, each 103ft. high and of 33,000 cubic feet capacity, were erected at Ferryhill in the county of Durham, but the expected further fuel economy did not materialise. Clearly enough, the mark had been overshot in respect of furnace dimensions.

Bell was the first metallurgist to understand the importance of the operation in the blast-furnace of the "law of mass action." He proved experimentally the reversibility of the interaction of carbonic oxide with oxides of iron, and thought he saw in it an "open sesame" to the problem of fuel economy. Whatever view may have to be taken eventually about Bell's particular conclusion as to the limit of fuel economy in a blast-furnace smelting Cleveland ore with Durham coke, there can be no gainsaying that he was perfectly right in his judgment about the importance of the principle of "mass action," which has since become recognised as one of the fundamental laws of chemistry. And even if some of his particular conclusions may have to be revised, nothing seems ever likely to happen to deprive him of the credit for having been the first metallurgist to grasp its meaning and to demonstrate its application to iron smelting.

Modern Researches.

Whilst subsequent experimental work has undoubtedly advanced our knowledge of the equilibrium states at various temperatures in systems containing oxides of carbon in contact with iron and its oxides, it leaves something to be desired in regard to the special problems of the blast-furnace. In the first place, the furnace gases are not mixtures of oxides of carbon only, but are largely diluted with nitrogen; and none of the recent investigators have worked with mixtures even approximating to the composition of the furnace gases. Moreover, only Matsubara, and to a less degree Chaudron, seem to have sufficiently appreciated the implications of the fact that the "equilibrium state" of the gaseous phase at any temperature may vary continuously with the composition of the solid phase. When it is once realised that at any temperature the CO/CO_2 equilibrium ratio for gases in contact with a material containing Fe_3O_4, FeO and possibly Fe also in varying proportions cannot but be influenced to some extent by what may be termed its "state of reduction," the problem is seen to be more complex than has sometimes been supposed.

Another factor which should not be overlooked in discussing the interactions between the gases and the ore, &c., in the blast-furnace is the possible influence of "adsorbed" gas films upon the velocities of the different reactions. The modern investigation of interaction between gases and the surfaces of solids has shown that such adsorbed gas films often play a controlling part, and, for anything known to the contrary, the actual velocity at which the oxygen of the ore is removed by carbonic oxide at any temperature in the blast-furnace may be influenced by adsorbed films of nitrogen or steam, in which case the rate of driving of the furnace would disproportionately affect the rate of ore reduction, especially in the upper part of the furnace. This is a matter now under consideration in connection with these researches, and, although so far it has not been possible to test it experimentally, it will not be lost sight of.

Whilst the ascertainment of the equilibrium CO/CO_2 ratios at various temperatures in such systems as [Fe_3O_4—FeO—Fe—CO—CO_2] is undoubtedly of great importance, from the point of view of the blast-furnace it would be more important still to determine, if possible, the actual reaction velocities. So far as the authors are aware, no one has hitherto attempted to do so. The experimental difficulties involved are undoubtedly very formidable, but not insuperable. In some measure the authors have succeeded in making a beginning with such determinations, and they believe they could be carried much further if only the appliances and assistance necessary to complete success were available.

Outline of the New Investigation and its Results.

The prime object of the authors' experiments has been to ascertain, by the best laboratory methods available, the facts concerning the interactions between oxides of carbon, when diluted with much the same proportion of nitrogen as in blast-furnace gas, and oxides of iron, &c., at temperatures between 380 deg. and 650 deg. Cent., which is an important range from the point of view of "carbon deposition" in the furnace. For this purpose they have chiefly employed (*a*) gaseous mixtures initially containing 34 per cent. of carbonic oxide and 66 per cent. by volume of nitrogen, hereinafter referred to as the "blast-furnace (or 'B.-F.') mixture," and (*b*) two ores, referred to as A and B respectively, A being a hematite containing 82·36 per cent. Fe_2O_3, kindly supplied by the Barrow Hematite Iron Company, and B a Spanish Rubio ore containing 75·41 per cent. Fe_2O_3, kindly supplied by Guest, Keen and Nettlefolds, Ltd.

Experimental Method.

The experimental method employed was essentially the "circulation method" introduced by one of the authors many years ago for the investigation of "surface combustion" and similar interactions between gases and solids. Briefly, the procedure consisted in continually circulating the B.-F. mixture at a pressure of about 630 mm. in a closed system comprising (*a*) a quartz reaction tube containing one of the ores in question, maintained at some selected constant temperature between the limits referred to; (*b*) a manometer; (*c*) an automatic "circulating pump"; (*d*) a series of "by-passed" gas sampling tubes; (*e*) a suitable drying agent to ensure the gaseous mixture being kept in a constant hygroscopic condition throughout a given series of experiments; and (*f*) a "capacity vessel" of convenient size. The course of events in each experiment could be followed by making simultaneous pressure readings and gas analyses at selected time intervals until equilibrium was attained. The "by-passed" gas sampling tubes enabled this to be done without altering the pressure of the main body of the gas in the apparatus.

The quantities of gas and ore used in any one experiment were so chosen that the ultimate attainment of equilibrium in the gaseous phase would not involve the removal of more than a small fraction—never exceeding 10 and usually less than 5 per cent.—of the total available oxygen in the ore used. This meant that, owing to the smallness of the alteration in the solid phase, it was possible in each experiment to study the rate of change and final equilibrium in the gaseous phase in relation to a solid phase of nearly constant composition, and, by successively carrying out at each selected temperature a series of such experiments, in which all conditions were kept constant except the initial composition—*i.e.*, "state of reduction"—of the solid phase, the oxygen content of which was diminished step by step in successive experiments, it was possible to correlate variations in the gaseous equilibrium and the velocity of its attainment with changes in the state of ore reduction until no further oxygen was removed.

During the greater part of the investigation to date, calcium chloride-dried B.-F. mixtures have been employed, because it was important, first of all, to establish reliable data for reaction systems which, although not absolutely dry, contained relatively little water vapour. This first objective being accomplished, the study of the effects of adding known small proportions of water vapour or hydrogen to the gaseous phase was begun. No previous investigator seems to have considered this point; but these experiments show it to be a most important one, and that herein may even lie the key to the explanation of the efficiency of dry blast.

Experimental Results.

The investigations have covered the interactions between the calcium chloride-dried B.-F. mixture and each of the ores A and B, at various stages of deoxidation in each case, respectively at four selected temperatures, namely, 380 deg., 450 deg., 550 deg., and 650 deg. Cent. Within such temperature ranges the carbonic oxide in the B.-F. mixture either reacts or is capable of reacting, with the ore charge simultaneously in two different ways, namely—(*a*) it may deoxidise the ore, or (*b*) it may effect "carbon deposition." An outstanding new fact which has emerged is that at each temperature the reducing reactions (*a*) always predominate during the initial stage of ore reduction, (*b*) coming into play only after a certain amount of oxygen, according to the temperature, has been removed. Once carbon deposition has begun, however, it proceeds at a rapidly accelerating rate, as oxygen is progressively removed from the ore, whilst the rate of ore reduction is concurrently decelerated, until eventually a certain stage of reduction is arrived at, dependent mainly on the temperature, but also to a less extent upon the nature of the ore, after which practically all the usable carbonic oxide† is utilised in "carbon deposition" and practically none of it in "ore reduction." The particular stage of reduction at which this occurs in the case of any ore at each particular temperature, may be called the "reduction limit" of the ore at such temperature.

The variation of these "reduction limits" with temperatures for the two ores in question, under the experimental conditions, was as follows:—

Temperature, deg. Cent.	Percentage of oxygen removed up to the reduction limit. Ore A.	Ore B.
380	11·5	12·4
450	13·7	—
550	23·0	37·4
650	—	100·0

Temperature 380 *deg. Cent.*—With the virgin ore, upwards of 90 per cent. of the total carbonic oxide originally in the system was used in "ore reduction," and less than 10 per cent. of it in "carbon deposition." This state of things continued until about 10 to 12 per cent. of the available oxygen in the ore‡ had been removed. Once past such a stage in the "ore reduction," the foregoing state of things was rapidly reversed, with the result that "ore reduction" practically ceased, and all the remaining "usable carbonic oxide" was utilised in "carbon deposition" until an equilibrium CO/CO_2 ratio of 0·3 had been attained.

Temperature 450 *deg. Cent.*—At this temperature only ore A has been investigated. Until about 8 per cent. of the oxygen in the ore was removed, upwards of 90 per cent. of the CO in the system was utilised in "ore reduction." Subsequently, this state of affairs rapidly altered until, when 13·7 per cent. deoxidation of the ore had been reached, the position was completely reversed, the whole of the usable CO now being utilised for "carbon deposition." The latter proceeded until an equilibrium CO/CO_2 ratio of 0·4 was attained. It thus appeared that the results at this temperature were not very materially different from those at 380 deg. Cent., except that reaction velocities—a discussion of which is reserved for a future paper—were all many times faster. Similarly, the time taken for the attainment of the final equilibrium was now very much shorter. It was thus evident that between 380 deg. Cent. and 450 deg. Cent. there was a considerable acceleration of all reactions.

Temperature 550 *deg. Cent.*—Here again, with a virgin ore over 90 per cent. of the total CO was utilised in "ore reduction" until somewhere about 10 per cent. deoxidation had been effected. This state of affairs then underwent a rapid change, the "ore reduction" reaction diminishing and the "carbon deposition" correspondingly increasing until the "reduction limit"—which for ore A was 23 per cent., and for ore B 37·4 per cent.—had been reached, after which ore reduction ceased, all the "usable CO" being utilised for "carbon deposition." The resultant equilibrium CO/CO_2 ratio at this temperature at the ore reduction limit was about 0·9 for both of the ores.

Temperature 650 *deg. Cent.*—Ore B only was completely investigated at this temperature, although so far as the experiments with ore A have gone, their results have been almost the same as those obtained with B.

In one respect—namely, that up to about a 10 per cent. deoxidation, nearly all the carbonic oxide in the system was used up in "ore reduction"—the results at this temperature presented no new feature. In other respects, however, a striking difference was observed, in that after the 10 per cent. deoxidation point had been passed, although ore reduction was decelerated, no "carbon deposition" supervened until 90 per cent. of the oxygen originally in the ore had been removed. Indeed, at this temperature the carbonic oxide proved to be capable of removing the whole of the oxygen from ferric oxide, there being no "ore reduction" limit.

It was thus evident that the reason why, at this and all the other temperatures investigated, the whole of the carbonic oxide in a Fe_2O_3—CO system can be utilised for "ore reduction," until, but not after, about 10 per cent. of the original oxygen in the ore has been removed, lies in the irreversibility of the reaction—

$$3\,Fe_2O_3 + CO = 2\,Fe_3O_4 + CO_2.$$

When once this stage in the ore reduction has been passed, however, the reactions concerned in the remain-

* Iron and Steel Institute—Abstract.

† By "usable carbonic oxide" is meant the maximum amount which can be utilised at each temperature, having regard to the existence of an equilibrium CO/CO_2 ratio.

‡ By "available oxygen in the ore" is meant the oxygen in the Fe_2O_3.

ing stages are all reversible. Hence, if no other interaction—such as that involved in "carbon deposition"—supervenes, a definite CO/CO_2 equilibrium ratio should eventually be attained at each particular temperature.

It would seem as though 650 deg. Cent. is the upper temperature limit for the occurrence of any marked "carbon deposition." Probably it will not altogether cease at higher temperatures towards the ultimate stage of ore reduction, but its influence upon the furnace reactions generally will be relatively small, and in particular it will no longer impose a limit on ore reduction.

Influence of Water and Hydrogen.

The results dealt with so far have reference to fairly dry systems from which hydrogen has been excluded. In the blast-furnace, both water and hydrogen are always present. A systematic investigation of the effects of admitting them to the systems in question has therefore been commenced, but so far only one series of such experiments has been completed, namely, at a temperature of 550 deg. Cent.

The results show the importance of this aspect of the matter being thoroughly investigated at all temperatures, because, until the effects of steam and hydrogen are precisely known at all temperatures between, say, 400 deg. and 1200 deg. Cent., we shall remain in our present state of ignorance about what may prove to be a very important factor in the blast-furnace.

Time of Contact.

Another important factor which should always be considered in experiments of this kind is "time of contact," and this has not been overlooked. In the upper third of a blast-furnace the total time of contact between the gases and the materials comprising the charge is probably of the order of one to three seconds, whereas in laboratory experiments such short contacts can rarely be arranged for. Presumably the mere speed at which the gases traverse such a system would not affect the chemical equilibria at different temperatures, although the existence of adsorbed gas films at the boundary surface between the solid and gaseous phases may prove to be a factor of greater importance in controlling the rate of attainment of equilibrium than has been supposed hitherto. This is a matter upon which no final opinion can be expressed until it has been experimentally tested.

INDUSTRIAL BURSARIES IN METALLURGY.

The Company of Armourers and Brasiers has recently founded lectureships in metallurgy to be delivered in London. Arrangements have been made for two lectures to be delivered in the current session, one on "Corrosion," by Mr. Ulick R. Evans, at the Imperial College, and the other on "Special Steels," by Dr. W. H. Hatfield, at the Sir John Cass Technical Institute.

The Company has, with a view to promoting craftsmanship, founded senior industrial bursaries of £170 per annum and junior industrial bursaries of £50 per annum. The senior bursaries are founded to assist young men who have obtained honours at the final examination at the University of London for the Degree of B.Sc. (Eng.), (Mining) or (Metallurgy) but whose means are not sufficient to enable them to prosecute their further studies without assistance. The junior bursaries are founded to enable youths who have shown promise in their preliminary studies in subjects relating to engineering or metallurgy to continue those studies. Further particulars may be ontained on application to the Company, Armourers Hall, 81, Coleman-street, London, E.C. 2.

INSTRUMENT TRANSFORMERS AND RECORDING AMMETERS, VOLTMETERS AND WATTMETERS.

The British Engineering Standards Association has recently issued the two following standard specifications:—(*a*) Instrument transformers (No. 81, 1927), and (*b*) graphic (recording or chart-recording) ammeters, voltmeters and wattmeters (No. 90, 1927). These two specifications are revisions of the 1919 editions, and have been brought into line with other British standard specifications for electrical instruments, there now being a series of four up-to-date specifications, as follows:—(1) Indicating instruments, No. 89; (2) graphic (recording) instruments, No. 90; (3) electrical protective relays, No. 142; (4) instrument transformers, No. 81.

The instrument transformer specification deals with the testing of current and voltage transformers, the rated secondary current or voltage, ratios of transformation, limits of temperature rise and the rated burdens. Each type of transformer is graded into four classes, according to the use to which the transformer will be put, and the limits of error for each class are laid down. A useful series of appendices is included. They deal with such matters as the conditions affecting the construction and use of transformers, terminal markings, notes on the selection of current transformers, the limitations of single-turn current transformers and the method of measuring temperature rise.

The graphic (recording) instrument specification is, in effect, a sister specification to B.S.S. No. 89, 1926, special attention being devoted to the clock or other driving mechanism and to the effect of the pen-to-paper friction. Chart speeds and chart rulings are also dealt with, as are also the limits of error and the methods of testing for accuracy. The allowances to be made for the effect of external magnetic fields, changes in frequency, power factor and the amount of ink, &c., are specified. Appendices are included, dealing with notes on the accuracy of different types of instrument, charts and driving mechanism, terminal markings, &c.

Copies of these revised specifications may be obtained from the Publications Department, British Engineering Standards Association, 28, Victoria-street, London, S.W. 1, price 2s. 2d. each post free.

A TRACTOR FOR LAUNCHING LIFEBOATS

FOUR-WHEEL DRIVE LORRY CO., LTD., ENGINEERS

A New Lifeboat Launching Tractor.

For some years past the Royal National Lifeboat Institution has made use of caterpillar tractors at certain of its stations in order to replace horses in the work of launching lifeboats off flat, sandy beaches. The tractor generally employed was a modified agricultural tractor of the Clayton type with caterpillar tracks. Such a machine, although serving admirably for flat, sandy beaches, was found not suitable for launching a heavy lifeboat off a shingly beach or one on which soft mud or heavy boulders had to be encountered. With the object of obtaining a tractor which should be capable of dealing with the heaviest type of man-handled boats on any kind of beach, the Institution has recently had designed for it by the Four-wheel Drive Lorry Co., Ltd., of London and Slough, a new type of tractor fitted with a roadless creeper track. On Monday last we witnessed field trials of this new tractor near the builders' works on the Slough Trading Estate, which were successfully carried out. As our accompanying illustration shows, the trials were made with a reserve boat the Maria Stephenson, which, if we except the motor lifeboats which are now being increasingly employed, represents one of the heaviest types of lifeboat now in use. The ground over which the trials were made was rough in character and included one or two mud holes filled with water. A quantity of loose shingle was also strewn over part of the ground to create a condition similar to that which will be met in actual service. The tractor showed itself to be fully capable of hauling the boat, and also backing with its load, and tests were made with one track in the mud, both in mud, and with water thrown over the engine in imitation of the waves which will possibly be encountered in actual service. In practice the launching operation consists of hauling the boat down to the water's edge, and then turning in a half circle and backing the boat on its carriage into the sea until a sufficient depth of water for flotation is obtained. In the case of the tractor we are describing, the launching ropes beneath the boat are attached to the winding drum on the tractor, and the wire rope hauls the boat off its already inclined carriage into the sea.

The engine which drives the new tractor is of the Wisconsin type, specially modified by the builders and designed to work at any degree of inclination, not exceeding 30 deg. It has a bore of 5¼in., with a stroke of 5½in., and is constructed to give an output of from 60 to 65 B.H.P. when working on petrol and running at a normal speed of 1350 r.p.m. There are two constant-mesh gearboxes, which are designed to give tractor speeds of 12, 6 and 3, and 8, 4 and 2 miles per hour and two reverses, and also to provide two working speeds for the winding drum, which is fixed in a horizontal position with adjustable paying off gear at the rear end of the tractor. The drum carries 250ft. of ¾in. wire rope, and a hand brake at the side of the chassis is provided. The engine is offset, so that a low drive is obtained, and also for the convenience of arranging the driver's seat at the right-hand side of the engine. The controls are in front of the driver and the winding drum clutch is operated by a lever placed below the driver's seat. As the tractor may be washed by waves during a launching operation, means are provided to prevent water reaching the vulnerable parts of the engine. The carburetter and magneto are completely enclosed in a water-tight casing and the air intake is situated some 8ft. above ground level. Air is taken through a 2in. pipe enclosed in the vertical exhaust outlet, and a 1in. pipe is taken through to ventilate the magneto casing. The valve stems are shrouded by guards, so that water cannot easily penetrate into the engine. Although not fully waterproof, it is quite possible that the engine would continue to run for some time when totally submerged—a condition which, however, will scarcely be met with in service. The creeper tracks, which are clearly shown in our illustration, are of the standard B 3 type, manufactured by the Roadless Traction Company, Ltd., London. The front wheels of the tractor are furnished with large size standard Goodyear tires, specially intended for heavy work. The main tracks are each a little over 16in. wide, and are spaced 4ft. 10½in. apart, centre to centre. The distance between the front axle and the point of support of the creeper track is 8ft. 9in., and there is a further 22ft. 5in. to the centre of the tail axle on the lifeboat undercarriage. This is a standard carriage modified as regards its under arrangement to take the creeper tracks. The tracks are similar to those used on the tractor, but have a width of 18in., and are spaced a little over 9ft. apart between centres. The total weight of the unladen tractor is about 8½ tons, of which about 1¾ tons are carried by the front axle, 5½ tons by the central tracks, and 1½ ton by the rear tracks. The boat has a total weight of about 6¾ tons, practically all of which falls on the track supports, only about a quarter of a ton being carried on the turntable which is fitted at the rear of the tractor. After the trials were made the new tractor was sent to the Institution's station at Dungeness, where it will operate on a rough macadam road and a sandy beach strewn with boulders. It will subsequently be tried at Boulner in Northumberland and Hoylake in Cheshire, so that working experience on heavy sand, shingle, mud and clay will be gained. It is hoped that the results so obtained will enable the Institution to adopt tractors for launching a lighter type of motor lifeboat now under construction.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.

The fifty-fourth annual general meeting and conference of the Institution of Municipal and County Engineers will be held in Torquay from Wednesday, June 15th, to Saturday, June 18th, next inclusive.

On the Wednesday there will be a business meeting in the Pavilion in the morning, when the visitors will be received by the Mayor of Torquay, and the new President, Mr. Edward Wallis, M. Inst. C.E., installed and deliver his address. In the afternoon there will be a visit to Kingswear.

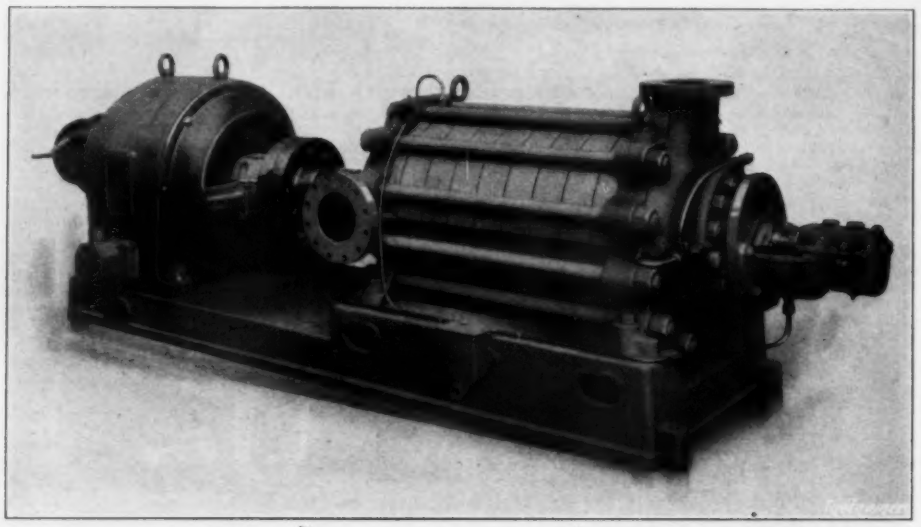
On the Thursday there will be meetings both in the morning and in the afternnon, during which there will be addresses by Sir Henry Maybury on "The Road and Transport Position in 1927," by Mr. E. A. Sandford Fawcett, M. Inst. C.E., on "The Engineering Departments of the Ministry of Health and Local Government Authorities," and by Mr. G. L. Pepler, on "Town Planning of Built Areas." The following papers will also be read and discussed:—"Some Problems of Seaside Health Resorts," by Major L. Roseveare, M. Inst. C.E.; "Slum Areas under the Housing Acts," by Mr. F. Marsden; "Sewage Disposal in 1927," by Mr. J D. Watson; and "Comparative Advantages of Powers for Pumping," by Mr. Arthur E. Collins, M. Inst. C.E. At 4 p.m. a garden party will be given by the Mayoress of Torquay, at Torre Abbey, and at 7.30 p.m the annual dinner of the Institution will take place in the Town Hall.

On the Friday there will be a motor coach ride to Exeter, *vid* Babbacombe, Teignmouth, Dawlish, Kenton, Exminster, and from Exeter there will be alternative visits to (*a*) the Exeter sewage works, and (*b*) the Exeter waterworks at Pynes. The return to Torquay will be by way of Dunsford, Teign Valley, Chudleigh, Knighton and Newton Abbot. On the Saturday there are to be visits to various places in the neighbourhood of Torquay.

Industrial Liverpool.—"Industrial Liverpool" is the title of a brochure which has been issued by the Liverpool Organisation. The latter body, the offices of which are at 3, Lord-street, Liverpool, was founded to advance the interests of Liverpool, and to perform the functions of a Development Board for Merseyside. Among its other activities it offers its services to all business enquirers, and the present booklet gives information concerning such matters as:—(*a*) Choosing a factory site; (*b*) Liverpool, the Seaport; (*c*) What Liverpool Makes; (*d*) Labour; (*e*) Environment; (*f*) Electricity; (*g*) Gas; (*h*) Water; (*i*) Rates; (*j*) Coal; (*k*) Transport; (*l*) Canals; (*m*) Roads; (*n*) Coastal services; (*o*) Oil; and (*p*) Storage accommodation. The brochure is well printed and illustrated, and since the information it contains may be regarded as being absolutely accurate, it should prove of value to those who are considering the question of establishing factories on Merseyside.

TEN-STAGE CENTRIFUGAL FEED PUMP

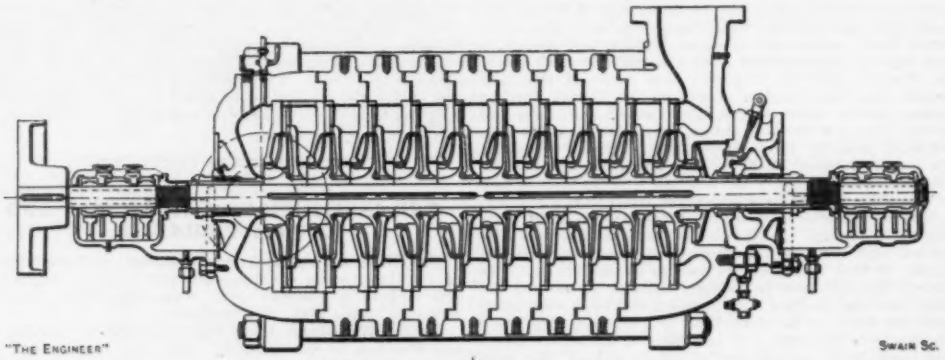
HOLDEN AND BROOKE, LTD., MANCHESTER, ENGINEERS



Ten-Stage Centrifugal Feed Pump.

THERE have recently been constructed for Shanghai Municipality by Holden and Brooke, Ltd., Manchester, three electrically operated ten-stage boiler feed pumps, each designed to deliver 25,000 gallons of water per hour at a temperature of 212 deg. Fah. against a total pressure of 500 lb. per square inch. The speed at which the pumps work is 1470 revolutions per minute, and the specified efficiency is 73 per cent.

The general design of a complete unit is shown above, while a sectional elevation of the pump only is given below. From the latter it will be observed that there are ten impellers which are mounted on the shaft in groups of five on two long keys, it being the contention of the makers that separate keys for each impeller are inadvisable on account of the possibility of one of the keys being missed out during reassembly after dismantling for inspection purposes. It will be noted from the sectional view that the shaft throughout its entire length is prevented from coming into contact with the water by means of long sleeves cast integral with the impellers, while other sleeves are provided where the shaft passes through the stuffing-boxes. The sleeves and the impellers are locked rigidly together by means of nuts outside the pump casing.



TEN-STAGE CENTRIFUGAL PUMP

A feature of the design, which will appeal to the engineer-in-charge, is the large space which exists between the ends of the stuffing-boxes and the bearing caps, so as to enable the former to be re-packed when necessary with the minimum of trouble.

The bearings are of robust constructon and are fitted with oil ring lubricators. Each bearing is provided with a water excluder and an oil retainer. The housings are of cast iron, while the bearings are lined with anti-friction white metal. The bearings with their housings can be removed without disturbing the shaft or any other portions of the pump, and in order to facilitate this operation the oil rings are of the split-hinged type.

Renewable bronze rings are provided at the eye of each of the impellers, and also at each point where the impeller sleeves pass through the passage blocks. The impellers are made of a special high-tensile bronze and each is carefully balanced separately, the whole series then being assembled on the shaft, after which the complete unit is re-balanced. The steel shaft has been given such proportions that its critical speed is considerably in excess of the running speed of the set, so as to avoid synchronous vibration. There are no screws used in the internal parts of the pump, so that the possibility of damage due to the screws becoming loose or not being replaced is avoided. After passing through the impellers the water passes into diffusers designed to convert the kinetic energy into potential energy. These diffusers are also made of a special bronze mixture. End thrust is taken up by means of a special balance piston situated at the discharge end of the pump. With this arrangement any slight wear on the piston faces is automatically taken up by the slight axial movement of the shaft. No extra balance water is required as the outlet is controlled by an orifice which is independent of any of the running parts of the pump. The passage blocks, and the suction and discharge covers are of a high-grade cast iron and are all held together by means of longitudinal bolts of high-tensile steel.

The motor is mounted on the same base plate as the pump, and the drive is through a flexible coupling. The driving pins are of steel, and on the pins are thimbles covered with rubber, the rubber being moulded direct upon corrugated brass sleeves, to prevent any possibility of its becoming detached. This type of coupling possesses all the flexibility which is desired. The motor is one of the British Thomson-Houston Company's design. It is of the protected slip-ring type with brush lifting and short-circuiting gear, and is designed to exert 220 brake horse-power at the coupling. It is fitted with ring-lubricated journal bearings, and the bearing caps and liners are removable without disturbing the end shields, coupling or collector gear. The electricity supply is three-phase, 50 period, at 300 volts.

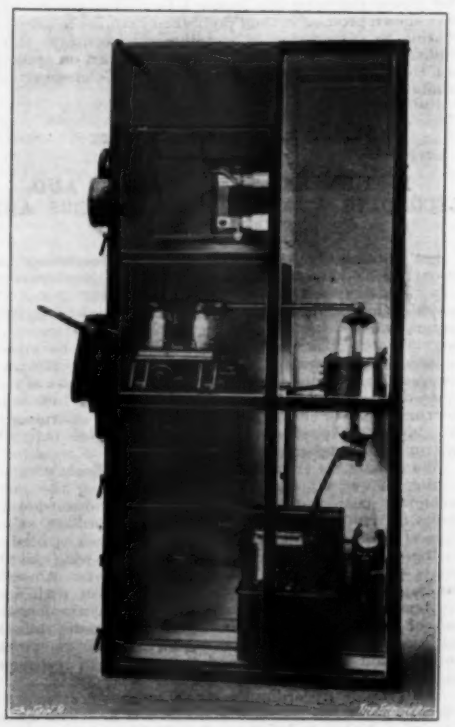
Cubicle Switchgear.

THE manufacture of high-tension switchgear cubicles has been taken up by George Ellison, of Perry Barr, Birmingham, and an example of this class of gear was exhibited at the British Industries Fair. The switch cubicle illustrated has been designed for a pressure of 11,000 volts, and a number of these units can, of course, be erected together with continuous bus-bars to form a switchboard, each unit being housed in stationary cubicles composed of steel. Each cubicle may contain one or two sets of three bus-bars, pole-operated isolating switches, a hand operated circuit breaker, current and potential transformers, instruments, meters, signal lamps, and interlock connectors. The current carrying capacity of the particular unit illustrated is 300 ampères per phase, whilst on a symmetrical short circuit the three-phase breaking capacity at 11,000 volts is 150,000 kilovolt-ampères.

The breaker oil tank is completely filled with oil, and a vent is provided on the breaker to carry away the gas formed by breaking the circuit on load. All the interconnections are composed of copper rod, which is covered with insulating material; straight connections being enclosed in "Tufnol" tube, whilst bends and joints are covered with "Plastol," which can readily be removed when alterations in the connections are necessary. All the clearances conform with British Standard Specification No. 116, and as no metal is exposed except at the contacts, exceptional safety is secured. The design has, in fact, all the advantages of compound filled gear, with the additional advantage that all the parts are accessible. The cubicle frames are composed of welded angle iron, and the enclosure of sheet steel. All the porcelain insulators, which are of the same type, are mechanically fixed and reinforced with "Tufnol" tubes where necessary. The breaker isolating switches and bus-bars are placed in separate cells in the cubicle. There are no live parts associated with the breaker that are above the oil, and the breaker is designed so that on breaking the load an increase of pressure in the oil tank forces the oil into a separate chamber from which it returns to the tank. A vent and duct enable the gas created by the circuit breaker to find its way to the outside of the cubicle. The oil tank, composed of ⅛in. boiler plate,

HIGH-TENSION SWITCHGEAR CUBICLE

is reinforced on the sides at the arc level and at the bottom, and it is raised and lowered by steel rope operated by a worm wheel drive. It is held in its working position by hand nuts on four hold-up rods, the ropes being capable of being cast off when the tank is in the lowered position to permit the removal of the tank. A hand lever on the front of the cubicle serves for closing and opening the



SIDE VIEW OF CUBICLE WITH CASING REMOVED

breaker, and the usual automatic releases are operated by transformer coils enclosed in a sheet iron box together with a very effective trip mechanism. Electrical interlocking with other gear can be arranged for by means of contactors in the trip box. Contactors may also be used for controlling signal lamp circuits. Cables may be arranged to enter from a trench to a dividing box at the bottom of the cubicle or alternatively through the top.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Conditions.

THE trade situation in the Midlands and Staffordshire shows no definite improvement, and demand for iron and steel by engineers and manufacturers is small. Orders of the hand-to-mouth variety continue, there being a persistent withholding of new business. The general policy of users is to keep stocks at the lowest possible limits, so as to enable them to take every advantage of the lower prices which are confidently anticipated. The weekly meeting of the Midland iron trade in Birmingham to-day was only fairly attended, and interest was weak. An improvement in the situation is, however, hoped for before the end of the quarter.

Pig Iron Values.

Midland blast-furnacemen have, up to the time of writing, made no move towards following the lead set a fortnight ago by North Country smelters in readjusting price levels. A reduction of anything like 5s. per ton under present conditions, they say, is not to be expected. They point out that Cleveland furnaces are getting coke at cheaper rates, and lower prices for coal are indicated. It is hoped that the *impasse* to which disproportionately high prices have brought us is now about to be relieved, commencing from the bottom and moving upwards. In the Midlands up to now, however, the same benefits from cheaper fuel as are enjoyed by Cleveland smelters are not applicable. True, there has, during the past week or so, been some weakening on the part of blast-furnace coke suppliers, but the official basis remains unchanged, and most blast-furnacemen are paying the fixed figure. Until a decided drop in fuel values is an accomplished fact, local pig iron producers will, they claim, be unable to reduce their prices. None the less, the downward trend of pig iron values continues in some slight measure. Here and there quotations are shaded in order to induce consumers to place orders. Most Derbyshire and Northamptonshire smelters still offer a stiff resistance to the demand for concessions. On 'Change to-day Derbyshire foundry was quoted from £4 to £4 2s. 6d. and forge £3 12s. 6d. Northamptonshire No. 3 was priced £3 17s. 6d. upwards and forge £3 9s. Smelters are not without hope that a reduction in prices will be declared before the end of the quarter, but it depends upon a fall in production costs.

Blast-furnace Coke.

The fuel situation is becoming increasingly easy. A fortnight ago I reported that a few contracts for blast-furnace coke had been booked at slightly below the official basis of 22s. per ton at ovens. The coke suppliers had been up to then adamant; now, it would seem, though there has been no official abandonment of the 22s. basis, an increasing number of sellers are prepared to shade this figure. Contracts at 20s. were stated to have been placed to-day. The breach having been made, Midland smelters hope soon to get that assistance from cheaper coke that the Cleveland district is enjoying. Midland industrialists are watching the position closely. They will expect the reduction to be passed on to them in the shape of cheaper pig iron.

Finished Iron.

The South Staffordshire finished iron trade is poorly off for orders, and the general situation shows no improvement on the conditions reported as prevailing a week ago. The class of iron used in the making of anchors, cables and chains is meeting with a fair demand, but calls for other grades are most disappointing. Marked bar prices are unchanged at £14 10s., and unmarked bars at £11. Common bars are available at £10 5s. Belgian bar iron can be bought delivered in the Black Country at £6. Hardly any continental material is being ordered, however, buyers showing the same reluctance to place orders abroad as for the Staffordshire product. The downward tendency in Belgian and French prices seems to have ceased for the time being. Business in tube strip is quiet and values are unchanged.

Steel.

There is no change to note in the steel position. Production continues at a high rate, many firms having old commitments to dispose of. Many mills can carry on for some time with old orders, but producers are disappointed with the volume of new business being arranged. Considerable benefit is expected to accrue as the result of contracts for new ships, but the moment for the giving out of orders for steel in connection with these schemes has not yet arrived. A steady demand exists for structural steel, which is in request for rebuilding and reconstruction schemes. Prices are fairly well maintained. Angles and joists command £7 15s., ship, bridge and tank plates £8 7s. 6d., boiler plates £11 to £11 10s. Small bars make £8 10s., Staffordshire hoops are £10 10s. at works, while native billets remain at £7. High-carbon billets are in good demand at £8 12s. 6d. There is a fairly active inquiry for sheet bars, sales being effected up to £6 12s. 6d. to £6 15s. for special grades. Quotations for continental material, whether finished or half-products, have an easy tendency, competition for orders being severe. Foreign billets are obtainable at £5 8s. A large amount of strip is coming into the district from Germany and Belgium at prices with which home manufacturers cannot possibly compete.

Galvanised Sheets.

The market for galvanised sheets is still somewhat fitful, but district mills are less ready to cut prices in order to get new business. Transactions on 'Change in Birmingham to-day—Thursday—for 24 gauge corrugateds were for the most part negotiated at about £14 15s. Good export orders, it is understood, would be accepted at slightly lower rates. New business is coming in a little more freely, especially for the thinner gauges.

Birmingham to U.S.A.

It is a matter for regret that exports to the United States from the Birmingham consular district during the first quarter of the current year were 25 per cent. less than in the corresponding period of 1926. Leather, and leather manufactures, again constituted the biggest item. It is of interest to note that needles were exported to the value of 167,735 dollars against 253,418 dollars; metal manufactures, 120,725 against 185,634; iron and steel manufactures, 88,203 against 150,608; pens, 73,354 against 65,398; steel sashes, 64,792 against 65,200; fishing tackle, 53,061 against 49,230; machinery and vehicles, 52,067 against 60,017 dollars.

Rolling Stock Works.

Rolling stock works in the Midlands are busy working off old contracts which they were unable to execute last year owing to the lack of raw materials and fuel. The position in this respect has eased a good deal, though even now shortages of steel are occasionally heard of. Demands for iron and steel from this quarter are maintained.

Birmingham to the Sea.

Important references to the Birmingham-to-the-Sea scheme were made at the annual meeting of the Sharpness New Docks and Birmingham Navigation Company. The chairman, Sir James Bruton, said that the effect of the Sharpness Company owning the Worcester and Birmingham Canal had been of immense service to Birmingham, Bristol, Cardiff and Newport, on account of the very low railway rates for certain traffic which were in operation. Negotiations had taken place from time to time with Birmingham and Bristol in respect to the loss the company was sustaining on account of keeping the navigation open, and if some assistance from the parties who were deriving the benefit by its continuance was not forthcoming, the Board would seriously have to consider its position in the matter. Sir William Bowater said the loss to the company of keeping the canal open was £8000 yearly, whilst the Severn Commissioners lost about £5000 a year in that connection. For a sum of about £13,000 or £14,000, the route could be maintained as it was now without any loss to anyone. The Bristol and Gloucester authorities felt strongly that the canal should be kept open, and it only remained for Birmingham to do its part. The question of enlarging the canal so that it could take 100-ton barges instead of the 40-ton barges as at present was in abeyance. He thought there was a fair prospect that the authorities at Bristol and other public authorities on the route to Birmingham could give the £13,000 necessary, but if that could not be done, it was suggested that a call could be made upon the local authorities and the local merchants and manufacturers to guarantee a given volume of traffic or to make up its equivalent in money.

Unemployment.

The latest unemployment return for the Midlands is again extremely satisfactory, showing as it does a marked improvement in the labour situation. The current total of 148,620 is less by 11,196 than that shown in the return for the previous week, and brings the total unemployed to well below the figure ruling before the Easter holidays.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinists' Order Books.

GENERALLY speaking, makers of textile machinery in Lancashire are not too satisfactorily situated from the point of view of work in hand. Very little support is forthcoming from the domestic textile industry, and unless there is a distinct change in its fortunes, not much support can be expected for some time. The bulk of the business that is being done now is for export markets, and shipments continue on a moderately good scale. A marked improvement in the situation of one important Lancashire firm of textile machinists—Howard and Bullough, Ltd., Accrington—was referred to in the chairman's address at the annual meeting of shareholders of that company. Sir George Bullough, who presided, said that since January a distinct revival in trade had set in, and that the company was now very busy. Its order book was in a healthy condition, there was a steadily growing demand for its machinery, and it was looking forward to a normally healthy year.

Motor Omnibuses for Manchester.

The Tramways Department of the Manchester Corporation have ordered fifteen 32-seater single-deck saloon motor omnibuses from the Associated Daimler Company, Ltd. The vehicles are all to be built according to the Associated Daimler "Model 416," and will be fitted with 40-70 six-cylinder sleeve-valve engines. In accordance with the proposed new regulations to be laid down by the Ministry of Transport the chassis have been designed for light, fast passenger work.

Personal.

Salford Corporation Electricity Committee has appointed Mr. L. Romero to succeed Mr. S. J. Watson as chief electrical engineer. Mr. Romero has been in the Salford service for over twenty years, latterly as mains engineer. Mr. Watson, the present engineer, has been appointed chief electrical engineer of the London and Home Counties Joint Electricity Authority. Presentations by colleagues on the staff of the Manchester Corporation Electricity Department have been made to Mr. H. A. Ratcliff, deputy chief engineer, who has been connected with the department for about thirty years. Mr. Ratcliff has been appointed chief engineer to the London Power Company. It was pointed out during one of the presentation ceremonies that in 1897, when Mr. Ratcliff joined the department, that the number of units supplied was a quarter of a million, compared with the present figure of over 300 millions, while the maximum demand had increased from 2737 to 140,960 kilowatts.

Non-ferrous Metals.

Greater steadiness in most sections of the non-ferrous metal market has been in evidence during the past week, lead being the one exception. In no instance, however, have fluctuations been spectacular in either direction. A sharp advance in the tin section following the publication of the month-end statistics, which indicated a serious decline in visible supplies, was not maintained, and the £300 mark, which was then touched for spot metal gradually tapered off, values at the time of writing being £2 to £2 10s. below the highest. Market opinion is that the reduced supply position had already been discounted early last month on rumours. Closing prices, however, represent a slight improvement compared with those that were ruling a week ago. Recent buying of the metal has been fairly active, although most of it has been of a speculative nature, industrial consumers, apart from a slight increase in purchases for spot delivery due to fear of a possible scarcity, showing little inclination to extend their operations. An advance of £1 to £1 5s. per ton in copper, according to position, brings values in that section of the market higher than they have been for about a month. Here, again, the statistical position as disclosed by the April estimates of domestic stocks, has been a "bull" point, the official stocks at 25,500 tons being 2500 tons lower than at the end of the previous month. Partly on this account, but partly on the strength of American advices, current quotations are steady. Cable makers have been taking fair quantities of the metal. From the same source there has also been some active buying of lead, but in spite of this and of a steady consumption on the Continent, quotations have further receded, and present prices are the lowest that have been touched this year. The knowledge that heavy stocks of lead are held has naturally had a bearish influence on the market. Spelter has registered a slight recovery, and although there has been little actual improvement so far there are hopes that the galvanising trade will shortly be compelled to enter the market for fairly substantial quantities.

Iron.

Important as last week's reduction in Middlesbrough foundry iron undoubtedly was, viewed simply as a reduction, the "cut" has been of far greater importance in its effect on the market for other varieties of pig iron. To the market observer that was not an unexpected result. As was indicated in this column a week ago, current values of Middlesbrough iron make it keenly competitive in Manchester itself, while in certain parts of Lancashire the advantage is very much on the side of the North-East Coast product. Consequently, whilst Midland makers maintain their quotation of 80s. at the furnaces for Manchester, they are cutting severely in respect of those areas where this course is essential in order effectively to meet the competition. Derbyshire and Staffordshire brands for delivery into Manchester or equal are on offer at 87s. 6d. to 88s. per ton, Middlesbrough being quoted at 88s. 2d., and Scottish at about 100s. An easy feeling is apparent in the case of hematite, East and West Coast products being quoted at 93s. 6d. In many instances, foundries have plenty of pig iron due to them under old contracts, so that there is little need yet to worry about making fresh forward contracts. In other cases, buying is virtually limited to prompt delivery needs. It is of interest to note, too, that cargoes of foreign iron for consumption in this district continue to arrive. Bar iron remains quiet, but unchanged at £11 per ton for Crown quality and £10 for seconds.

Steel.

As has been previously stated, constructional engineers at the moment have the brightest outlook among the heavy steel consuming industries in Lancashire. It is from this source, therefore, that sellers are chiefly looking for business. For the time being, however, most constructional engineers are content to buy against existing contracts, and are doing little beyond spasmodic buying of odd parcels. Certainly there are no contract commitments of any importance being concluded at this stage. Under the circumstances, prices are easy with joists and sections quoted at from £7 12s. 6d. to £7 15s., according to delivery, ship and tank plates at about £8 7s. 6d., boiler plates at £11 7s. 6d., and steel bars at £8 5s. to £8 17s. 6d. In the market for continental steel materials, virtually no interest is being taken in the semi-finished products, and values of these are nominal in consequence. The demand for the finished materials is of limited dimensions, and in most cases quotations are weaker at £6 18s. to £7 for ordinary plates, £7 5s. for Siemens plates, £5 17s. 6d. to £6 for sections, £5 15s. for steel bars, £6 7s. 6d. for wire rods, and £5 15s. for Belgian bar iron, these prices being for cash against shipping documents, and including delivery to buyers' works in the Lancashire district. A welcome improvement in the demand for galvanised sheets has been in evidence during the past week, more particularly from the Indian market. From the level of £14 12s. 6d. quoted here a week ago, values rose to about £14 17s. 6d., and have since steadied at £14 15s. per ton f.o.b. for the 24-gauge materials.

BARROW-IN-FURNESS.

Hematite.

The slight easing in price has not had a very marked effect upon the market, and it seems as if customers, expecting further falls in the prices of various qualities of hematite pig iron, are content to place moderate orders covering the immediate future rather than commit themselves to orders for a long period ahead. That is quite natural. There is no

cause to be alarmed, for it is pretty well known that the consumers' requirements are likely to be fairly heavy for the most part of this year. The price of coke is going to be the determining factor in the market, and it is not expected that it will fall rapidly. In the meantime the demand for deliveries and the requirements by the steel departments in the district preclude any stocks accumulating; in fact, practically little or no iron is going into stock. In special qualities the deliveries keep up and are likely to for some time. A moderate amount is going to the Continent.

Iron Ore.

The iron ore trade continues to be brisk and steady, and the mines are producing ore in bigger tonnage since the restart than they have for years. A certain amount of local ore is going out to Scotland and the East Coast, but the tonnage is not heavy. Importations of foreign ore are steady, and ships are chartered for cargoes well ahead. In the steel market there is not much life, and orders are not coming in as fast as steel is going out. Barrow continues on rails, but Workington has only been producing sleepers, tires and axles. The rail mills will restart in a day or two. The hoop and small section mills at Barrow are well employed and well booked up for orders.

SHEFFIELD.

(From our own Correspondent.)

Few Orders for Steel.

EXCEPT for oddments, practically no new business for steel is being placed, and the open-hearth steel furnaces, with their great rate of production, are faced with a prospect that is very far from being pleasant. Having virtually completed the accumulation of orders on which they have been working at full capacity since the beginning of the year, the furnaces are now working to place material to stock, but there is a severe limit to this policy, and there will have to be a sharp curtailment of production soon unless trade gives sufficiently definite signs of improving to justify the steel makers in keeping their furnaces going. Already, as I mentioned last week, two of the large furnaces have been closed. One of the serious features of the situation is the absence of steel contracts, and buyers seem disinclined to place them on the present terms. The iron and steel markets continue to ease as a result of the absence of forward business, and Derbyshire and Lincolnshire pig iron has been reduced by 2s. 6d. a ton. Though this reduction has been welcome, iron is still considered to be too dear. The coke makers are maintaining their prices, and as the majority of users do not care to commit themselves to a twelve months' contract for the reduction of 1s. a ton that is being granted, it means that the bulk of the coke passing through the market is carrying the high price of 22s. a ton at the ovens. At this figure it is difficult to see how the pig iron makers can be paying their way after the recent reduction; indeed, some state definitely that they are losing money.

Foreign Railway Steel.

Some strong criticism has been forthcoming in Sheffield of what is said to be the growing policy of certain British railway companies of threatening to place work on the Continent unless the Sheffield prices are cut, and indeed in some cases actually placing business there. It is stated that at least two companies have been buying tires and axles made on the Continent, and in one case the delivery, it is said, consisted of seriously defective material. The company received from a well-known German steel firm a large number of locomotive tires, and when these were being fitted at the company's workshops two broke. This naturally caused an investigation of the rest of the consignment to be made. Each sample taken broke at the first test and the whole lot had to be taken off the engines and virtually scrapped without having run an inch. During the last few months, it is stated, the railway companies have been getting very particular with their specifications for home makers and have been rejecting delivery for the least variation. On common tires the saving is about £3 a ton by buying foreign material. It is only since the war that the Belgians and Germans have been making the high-tensile tires for which Sheffield has been famous for many years. The Sheffield Chamber of Commerce has also recently published an exposure of the sending to South Africa of defective railway material from foreign countries.

Lighter Steel Trades.

The busiest departments in Sheffield to-day are those making material for the motor and electrical industries, and it is these sections which are at present largely helping to maintain trade activity in the city. Full tme is being worked at the Metro-Vickers' works at Attercliffe Common, and other electrical plants in the district are also well employed. Trade in steel, files and tools in the Far Eastern market is being badly hit by the trouble in China. Sales have fallen away considerably of late, particularly to China and Japan. Except for the customary batches of belated orders, the seasonal deliveries of farm and garden tools have been completed. Several makers of farm tools, implement parts and knives report that the season has been quite up to the average, but the section for garden tools has not been so satisfactory. One reason may be that small gardeners have been forced to practise economy, and another is that this year there has been increased competition from Germany. There has been a moderate sale of garden implements made of stainless steel, but the preference is undoubtedly still for what may be termed the old-fashioned type. The export markets in particular display a marked preference for the particular styles to which they have been accustomed.

Plate and Cutlery.

Trade in cutlery and plate remains just about as bad as it could be, and so much price cutting has been indulged in that it is doubtful whether any profit is being made on the present turnover. Works are now mainly relying on contracts for the large establishments with catering interests, and on colonial sales, which remain at a fairly good level. Counter trade to members of the general public is at an extraordinarily low level, and travellers for plate and cutlery firms are having a lean time. A brisk trade, however, is being done in safety razor blades, the output of which continues to expand rapidly with additional firms turning their attention to their manufacture. Further experiments have been made with a view to producing a hard soldered all-stainless steel table knife similar to the knife with plated nickel silver handle, which is made for steamship lines and good-class hotels and restaurants. The all-stainless steel handles can be fastened by welding, but this process is stated to be too expensive to be a success as a commercial proposition, and a Sheffield handle manufacturer now claims to have perfected a system of soldering which will enable an all-steel knife to be produced as strong in all respects as the nickel silver hard soldered knife.

New Coke Ovens.

An order has been placed by the Nunnery Colliery Company, Ltd., Sheffield, with the Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Ltd., for a complete coke oven works, comprising a battery of twenty-five Becker ovens capable of carbonising 3600 tons of slack per week. The contract includes the erection of semi-direct by-product recovery plant, railway sidings, coal store, coal and coke handling plant and coke-screening plant. The new works are intended as a substitute for the present Nunnery coking plant, which will go out as the modern coke ovens come into operation. The existing ovens were constructed about sixteen years ago.

Improved Safety Lamp.

As a result of research work at Sheffield University, Professor R. V. Wheeler and Mr. D. W. Woodhead have produced a flame safety lamp which it is claimed—by Dr. J. S. Haldane, among others—will almost wipe out miners' nystagmus, because of the improved light it gives. The lamp, which has been demonstrated to members of the Midland Institute of Mining Engineers, has been improved simply by increasing the length of the lamp gauze by about 1¼in., and this has increased the intensity of the light from about ¾ candle-power to 2¾ candle-power. The improved lamp, of course, is not yet an "approved" lamp, but Professor Wheeler and his colleague have submitted it to a more severe test than that prescribed in the regulations, and it proved quite satisfactory.

Rebuilt Furnace.

Newton, Chambers and Co., Ltd., of the Thorncliffe Ironworks, Chapeltown, near Sheffield, blew out their No. 1 blast-furnace towards the end of last week and lit their re-built No. 2 furnace. Their third furnace has recently been dismantled. The work of rebuilding the No. 2 furnace was carried out by the firm itself, and a number of new features are embodied in the construction particularly as regards the methods of charging and filling.

Colliery Developments.

Guaranteed loans under the Trade Facilities Act are to be made to two companies for the development of the coal industry in the Sheffield and Doncaster districts. Pease and Partners, Ltd., are guaranteed £400,000 for twenty years for the development of Thorne Colliery, and security is given to the Sheffield Coal Company, Ltd., for £250,000 for twenty-two years for developments of its colliery at Aston. In order to cope with the growth of the village of Upton, near Pontefract, where a new colliery is being sunk, the Hemsworth Rural Council has completed a modern sewerage scheme, at a cost of £19,000. Owing to the smallness of the rateable values in the locality, the Council had some difficulty in finding the money to meet the expenditure, but through the Public Works Loan Board and the Upton Colliery Company, arrangements have been made which will not inflict undue burden upon the local ratepayers.

NORTH OF ENGLAND.

(From our own Correspondent.)

Coal Industry's Serious Position.

COLLIERY owners in Durham and Northumberland are seriously concerned as to the future of the coal export trade. As a result of a marked contraction in the overseas demand during the past few weeks, many of the pits in both counties are now working short time, and one large colliery will be closed down this week-end. Economically, both Durham and Northumberland are sliding into a very critical position. The official ascertainments of proceeds and costs in the industry make this fact only too clear. The yield of coal has not been nearly enough to pay the minimum percentage on basis rates. Next month the additions will be greater still, because the prices in April were lower than in March. Obviously, this state of affairs cannot last long. Producers assert that it is economically impossible to make any more cuts in prices, while merchants declare that they cannot secure orders at current prices, and that as a result business is falling into the hands of foreign competitors. Certainly the general position of the industry is very disquieting, and the anticipations held at the beginning of the year of a steady trade at remunerative prices have not been realised.

Cleveland Iron Trade.

The recent cut in Cleveland pig iron prices has had surprisingly little effect as a trade stimulant. Iron masters had clearly been hoping that a reduction of 5s. would bring in buyers, but the latter are apparently convinced that prices must fall still further, and are adhering strictly to a hand-to-mouth policy. The opinion is pronounced, however, that if the rather wide difference in the view of buyers and sellers as regards values could be narrowed down, an active market would be experienced. In all branches of the trade makers are keen sellers, but they are reluctant to make substantial price reductions, declaring that current quotations are barely remunerative, and there seems little likelihood of much reduction in the cost of production in the near future. The recent reduction in prices has, however, enabled merchants who made speculative sales to cover themselves, and local consumers who have been holding off have been tempted to place a few orders. In addition, home consumers from a distance have purchased a few parcels, but the difficulties of transacting business with Scotland and with continental countries are still great. In Scotland—usually one of Cleveland's best markets—foreign iron is being delivered at about 10s. per ton below the price of Cleveland iron, and with such a margin against them there seems little hope of makers here capturing much more trade north of the Tweed. No. 1 Cleveland foundry iron is 77s. 6d.; No. 3 G.M.B., 75s.; No. 4 foundry, 74s.; and No. 4 forge, 73s. 6d. per ton.

Hematite Pig Iron.

East Coast hematite pig iron is reported to be selling just slightly better to home firms, and continental inquiry, though still small, shows signs of improvement. Demand altogether, however, falls far short of what could be desired, and competition among makers for new orders is so keen that the price of mixed numbers has fallen to 81s. per ton.

Ironmaking Materials.

Consumers being well bought and having large stocks, business in foreign ore can hardly be looked for. Imports against running contracts are on a heavy scale, and merchants having good order books are able to quote rates on the basis of best Rubio ore at 22s. per ton c.i.f. Tees. Quotations for blast-furnace coke are still regarded as too high, and anticipating a further downward movement, consumers are markedly disinclined to enter into new contracts. On the other hand, producers complain that already prices are unprofitable. Business can be done in good medium blast-furnace qualities at 22s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

Tonnage output of manufactured iron and steel continues on a very heavy scale, but producers are anxious to negotiate for new work in order to ensure continuity of operations at the rolling mills. In some directions there is rather a tendency to withhold orders in the hope of price cuts. Trouble in the Far East has stopped business with China and Japan, but considerable sales of steel to the latter country are anticipated when order is restored. Prices are unchanged.

The Coal Trade.

The position in the Northern coal trade is anything but encouraging. Here and there a few odd orders have been secured, and some of the fitters report well-filled turns over the next week or two, but the majority find matters very dull, and not giving the slightest signs of improvement on the recent experience. Despite the low prices indicated, foreign buyers hold off, and forward inquiries are on a very limited scale. Fitters, as well as contractors, are now holding steadily to the recent range of prices, firmly adhering to the view that cut prices would not bring the foreigner into the market more quickly. Tenders have been forwarded this week to the Latvian State Railways for the supply of 40,000 tons of Northumberland and Durham steam coals to be shipped to named ports during May to September, and also to the Lithuanian Railways for 60,000 tons of Northumberland and Durham steam coals for shipment from May to December. The outcome of the offers of Northern producers is awaited with interest in view of the keen competition for the orders on the Continent. For Northumberland coals the position is about the same as last week. Some of the collieries are having considerable difficulty in disposing of their output, and in some instances short time is being worked. Best steams are quoted 14s. 3d. to 14s. 6d., and second qualities 14s. The small coal position is firm, there being a good demand and limited output, and prices are firmly held. Best kinds command 10s. 9d. to 11s., secondary sorts 10s. 6d., and specials 13s. to 13s. 6d. For Durhams the coking unscreened trade is very dull, and with ample stocks 14s. 6d. to 15s. is freely quoted. Gas coals, owing to limited output, hold steadily to 17s. for best qualities, and 14s. 9d. to 15s. 3d. for secondary grades. The demand for gas coke is quiet, and stocks are increasing. Prices are nominal at 20s. Patent foundry and furnace cokes are in good demand and steady at 21s. 6d. to 22s.

SCOTLAND.

(From our own Correspondent.)

Loch Luichart Hydro-electric Plant.

MESSRS. MURDOCH MACDONALD AND PARTNERS, the consulting engineers for the Ross-shire Electric Supply Company, Ltd., have placed the contract for supply and erection of pipes, water turbines and electrical plant required for the station at the outlet of Loch Luichart with James Gordon and Co., Ltd., Kingsway, London. The plant at present designed covers the installation of two 750 horse-power Francis turbines working under a head of 110ft. and running at 600 revolutions per minute, coupled to two 500-kilowatt generators, together with switchgear, transformers, &c., and about 40 miles of transmission line.

Steel.

The situation in the steel trade has not altered materially during the past week. Orders for steel plates and sectional material are not numerous, which may be

accounted for by the fact that few makers are in a position to guarantee delivery at present. It is said that English makers have been offering fair quantities of various classes of material in this market without affecting local prices so far. Some effect may be observed, however, when shipyard work becomes more advanced and work on hand at the steel works has diminished. In the meantime Scottish producers hold that quotations already touch lowest levels.

Steel Sheets.

Steel sheets experience a quiet spell, but inquiries from abroad appear to indicate improvement. Black sheets, ⅛in., have been quoted £10 for home and £9 15s. per ton export, while galvanised corrugated sheets, 24 gauge, were named £15 5s. home and £15 per ton export delivery.

Iron.

Bar iron continues inactive and the re-rolled steel departments are little better off, despite the recent reduction of 7s. 6d. per ton. The current price for the latter is £8 2s. 6d. per ton, but continental products are gaining preference at from 15s. to 20s. per ton less.

Pig Iron.

The number of furnaces in blast remains at thirty-five, eighteen of which are engaged on foundry qualities, fourteen on hematite, and three on basic. Considerable quantities of continental and Indian basic pig iron find a ready sale in this district at about 75s. per ton delivered. Local outputs of hematite are being disposed of round about 85s. to 87s. 6d. per ton, but No. 1 foundry at 89s. and No. 3 foundry at 84s. per ton do not experience a ready market.

Exports and Imports.

Exports of iron to Australia, New Zealand, China, Japan, South Africa, and Canada totalled 7400 tons last week. Large cargoes of machinery, cast iron and riveted steel pipes and tubes also left the Clyde during the same period. Imports of iron ore totalled only 2550 tons and iron imports from Antwerp 1770 tons.

Coal.

The Scottish coal market continues depressed and prospects discouraging. There are some, however, who view the early future more hopefully in the belief that the stagnation has been the result to a large extent of the flooding of markets with American and foreign coal owing to the strike last year. As stocks of these fuels must now be well-nigh exhausted, there may be good reason to anticipate improvement. Meanwhile orders from all sources are meagre, and in practically all districts treble nuts alone show a decided firmness. Despite the scarcity of business, many, if not all, of the collieries decline to shade their prices further. Over the coalfields employment is very irregular and additions have this week been made to the number of pits closing down until busier times. Aggregate shipments during the past week amounted to 274,168 tons, against 270,261 in the preceding week and 256,204 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

COAL shipments last week were very satisfactory and were little short of half a million tons. That figure was materially above anticipations, in view of the quieter tone prevailing. The returns for this week may possibly not come up to the same total, although the arrivals of tonnage last week-end were fairly good, and at both Cardiff and Barry steamers were waiting to get into berth on Monday. The docks all round were reported to be busy, but doubts are entertained whether that state of affairs will last any length of time. Chartering is falling off. Tonnage is not so easily obtainable for early readiness, notwithstanding the fact that there are not many fresh orders in the market. Some disquietude is occasioned among merchants who are interested in the carrying out of orders for the Mediterranean by the amount of tonnage which is making its way westward, and, as a consequence, will be off the market for some weeks. A very considerable amount of tonnage is interested in the transport of coals from South Wales to Canada, but many owners have sent out their steamers to Montreal and also to the South American ports in ballast owing to the good homeward rates which have been obtainable for steamers which can give fairly early readiness out there. Rates of freight for the Mediterranean ports are already very firm, especially for the upper ports, and if many fresh orders came into the market, there is little doubt that present rates would sharply advance 6d. per ton. By the time this letter appears it is fully expected that news will have been received regarding the placing of the contract for 100,000 metric tons of steam coals for the Egyptian State Railways. The expectation is that the tender of Messrs. Furness, Withy and Co. will have been accepted. News is also awaited respecting the French Marine requirements. Outside of these there is not much of fresh interest in the market. The inquiry for coals from Italy is singularly quiet, and that is attributed to the stocks which buyers in that country already hold, and to the instability of the foreign exchange. Unfortunately there is a feeling in market circles that the conditions in the steam coal trade are likely to be less favourable during the next month or two than they are now. Collieries which produce the superior grades of coal are in most instances doing fairly well, but with others the position is far from good. Stocks are accumulating, and the falling off in the demand for pitwood is an almost infallible indication that the conditions at the pits are not so active.

LATER.

It is now definite that the contract for the supply of 100,000 metric tons of Welsh large steam coals to the Egyptian State Railways has been placed with Messrs. Furness, Withy and Co., whose price was 32s. 3d. c.i.f. Alexandria. The coals have to be delivered during May, June and July.

The Continental Trade.

Some anxiety has lately been caused by the attempts made both in France and Spain to set up barriers to the importation of outside coals for the benefit of the home producers. Months ago the Spanish Government issued a decree laying down the basis upon which coals could be imported and making it obligatory for various services to take a certain proportion of home-produced coals. At the same time it is satisfactory to find that shipments from South Wales to Spain are well maintained, but it is well that the future should be watched very closely. In the case of France, there is a movement to displace British coals by French coals at the French Coasting and Bay ports. The idea is to make France independent of coals from outside sources, and there is no disguising the fact that this country would be the chief sufferer. Both exporters on this side and French importers are displaying the utmost opposition to the scheme, and the feeling prevails that the difficulties that have to be faced will prove too big to enable those interested to carry through such a scheme, that would virtually mean the exclusion of British coals from French Coasting and Bay ports.

Dowlais Works Record.

Reference was made last week to the record output of pig iron from one furnace at the Dowlais Works at Cardiff, when the figure reached was 3400 tons. It was then indicated that at the rate they were working there was a prospect of this record for Great Britain being broken. This has proved the case, as the figures given for last week's output were 3500 tons, an increase of 100 tons upon the previous record.

Steel and Tin-plate Trades.

The conditions prevailing in the tin-plate trade are by no means satisfactory, and at some works operations have been suspended, while at others men have been given fourteen days' notices. It is hoped that the depression in the industry is only temporary. It is reported that some progress is being made concerning the formulating of a new basis for the sliding scale. As regards the steel industry there was a meeting of the Joint Industrial Council of the South Wales Siemens Steel Trade at Swansea at the end of last week, when a number of claims were put forward by the Iron and Steel Trades Confederation, one being that the sliding scale should be arrested at 15 per cent., the percentage operating previous to the 12½ per cent. resulting from the last ascertainment. Another claim was that the existing *ex-gratia* bonuses should be continued for a further three months. The employers felt that the present conditions prevented them from agreeing to the first claim, but they decided to safeguard the position of the lower paid men by increasing their present *ex-gratia* bonuses of 35 per cent. to 37½ per cent., which, with the sliding scale at 12½ per cent., gave them a gross amount of 50 per cent. above the base rates; in other words, there would be no change so far as these men were concerned for the next twelve months. In the case of the second claim the employers also agreed to this.

Miners' Federation.

There was a special delegate conference of the South Wales Miners' Federation at Cardiff on Monday. It was called for the purpose of considering ways and means of again building up that organisation. The upshot of the conference was that it was left to the Executive Council to make arrangements for an intensive propaganda throughout the coalfield.

Current Business.

The conditions in the coal export business are at the moment lacking any special feature. The demand from abroad is very quiet for almost all directions. At the same time many of the leading collieries are temporarily well placed for prompt orders, and have a good supply of ready tonnage, but there is a feeling that this is not going to last for long. Collieries producing inferior grades of coal are already in need of prompt business. The result is that the market is showing a certain amount of irregularity. Small coals are, however, slightly steadier on account of the rather more restricted production. Patent fuel is steady at last prices, but pitwood, which at the end of last week went up to 37s., is now easier at 33s. to 34s.

INSTITUTION OF NAVAL ARCHITECTS.

THE summer meeting of the Institution of Naval Architects is to be held in Cambridge from Tuesday, July 12th, to Friday, July 15th. It will be under the chairmanship of the Duke of Northumberland, President of the Institution. The Vice-Chancellor of the University (the Rev. G. A. Weekes, Master of Sydney Sussex College) and the other members of the Reception Committee will receive the members at the opening meeting in the Senate House.

The programme provisionally approved is as follows:—On the Tuesday, at 10 a.m., the opening meetings will be held in the Senate House, and various papers read and discussed. In the evening there will be a reception by the Vice-Chancellor of the University. On the Wednesday there will be an all-day visit to Bedford, where W. H. Allen, Sons, and Co., Ltd., will entertain members at luncheon in the Queen's Engineering Works. In the evening there will be a reception in the Engineering Laboratories, Cambridge.

On the Thursday further papers will be read and discussed in the morning, and there will be visits in the afternoon to colleges, and a garden party in King's College Gardens. The banquet of the Institution will be held in the evening in the Hall of Trinity College.

On Friday, July 15th, there will be an all-day visit to Ipswich, where the members will be received and entertained by Reavell and Co., Ltd., Ransomes and Rapier, Ltd., and Petters Ltd., and other members of the Reception Committee.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THOS. W. WARD, Ltd., Sheffield, ask us to announce that they have purchased, as a going concern, the Meadow Hall Ironworks, Sheffield, of J. Crowley and Co., Ltd.

ROBERT BLACKWELL AND CO., Ltd., ask us to announce that as from Monday, May 16th, their address will be changed from 36, Emperor's-gate, London, S.W. 7, to Mitcham-road, Croydon, Surrey. New telephone Nos., Thornton Heath 2410, 2411, 2412. Telegrams, "Kurkee," Croydon.

CONTRACTS.

BOULTON AND PAUL, Ltd., have received an order for a contract for lattice steel towers for India, to the value of £55,000, in the face of severe American and continental competition.

THE WOODALL-DUCKHAM VERTICAL RETORT AND OVEN CONSTRUCTION COMPANY (1920), Ltd., of Allington House, Victoria-street, Westminster, S.W. 1, have received from the Nunnery Colliery Company, Ltd., of Sheffield, an order for a complete coke oven works comprising a battery of twenty-five Becker ovens designed to carbonise 3600 tons of slack per week. The contract includes the erection of semi-direct by-product recovery plant, railway sidings, coal store, coal and coke handling plant, and coke screening plant.

STOTHERT AND PITT, Ltd., of Bath, have recently secured the following orders:—(*a*) From the Hoskins Iron and Steel Company, New South Wales, Australia, for an iron ore unloader, taking the form of a gantry jib crane with crank-operated horizontal luffing gear, to deal with a 20-ton working load, the maximum outreach from the front rail to be 48ft. About 7 tons of ore will be taken per lift, and an output of 300 tons per hour will be attained. Dispensing with the grab when desired, the crane will handle by means of slings a loaded hopper wagon; and (*b*) from the Falmouth Docks and Engineering Company, Cornwall, for a large electrical gantry crane for installation between two graving docks, fitted with the "Stothert and Pitt" horizontal jib luffing system. The lifting capacity is to be 30 tons on the main hook at 85ft. radius, and 10 tons on the auxiliary hoist at 91ft. radius.

LUBRICATION PROBLEMS.—We have just received from the Vacuum Oil Company, Ltd., of Caxton House, Westminster, four new numbers of the Gargoyle Technical Series—Nos. 26 to 29—dealing with the lubrication of colliery machinery, ball and roller bearings, rolling mills, and printing machinery. The booklets do not merely treat with the lubrication affairs of those industries alone, but give an outline of general practice in an easily readable form. The pages are well printed and illustrated, but there is a little slip where the Ilgner system of electrically-driving rolling mills is described as the Iginer. The publications are, nevertheless, full of useful information.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The Council of the Institution of Electrical Engineers has made the following award of premiums for papers read during the session 1926–27, or accepted for publication:—Institution Premium, to Messrs. J. R. Beard and T. G. N. Haldane; Ayrton Premium, to Lieut.-Colonel K. Edgcumbe, R.E. (T.A.), and Mr. F. E. J. Ockenden; Fahie Premium, to Mr. G. F. O'Dell; John Hopkinson Premium, to Mr. P. Dunsheath; Kelvin Premium, to Mr. J. W. T. Walsh; Paris Premium, to Mr. A. R. Cooper; Webber Premium, to Mr. W. McClelland; extra Premiums, to Dr. A. H. M. Arnold, Mr. F. W. Carter, and Dr. A. Rosen; Wireless Premiums, to Mr. T. L. Eckersley, Dr. R. V. Hansford, and Mr. H. Faulkner. The awards for papers read before students' sections will be announced later.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, May 9th, Sir Arthur Keith, treasurer and Vice-president, in the chair. Sir J. J. Thomson was elected Honorary Professor of Natural Philosophy, and Sir Ernest Rutherford, Professor of Natural Philosophy. The chairman announced that the President, his Grace the Duke of Northumberland, had nominated Sir James Crichton-Browne, Dr. J. Mitchell Bruce, Sir Dugald Clerk, Sir Ernest Moon, Hon. Sir Charles Parsons, Sir Almroth Wright, Sir Arthur Keith and Sir Robert Robertson as Vice-presidents for the ensuing year. Mrs. M. S. Atkinson Adam, Mr. D. K. C. Birt, Sir Arthur Duckham, Mr. P. V. Hunter, Dr. Samuel Insull, Mr. Archibald McKinistry, Mr. Charles P. Sparks, and Sir Alexander Walker were elected members.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—The decisions of the Examining Board for the fifth annual competition for the W. E. Highfield Shield, 1927, composed of Messrs. A. M. Sillar, W. E. Highfield, W. Lang and F. W. Smith, were announced at a meeting of the Association held at the Junior Institution of Engineers, London, on May 3rd, as follows:—*Members.*—Winner of the Shield and first prize, value £4 4s., presented by the Board of Control, G. H. Conway, Acharacle, Argyll, for paper on "Electrically-heated Glasshouses"; second prize, value £2 2s., presented by V. G. Middleton and Co., Ltd., B. C. Garman, London, for paper on "Notes on Electric Cooking Apparatus"; third prize, value £1 1s., presented by Johnson and Phillips, Ltd., E. J. Davies, London, for paper on "Electricity as Applied to the Asphalt Industry." *Associates.*—First prize, value £2 2s., presented by Messrs. Hogan and Wardrop, T. V. Harding, Colchester, for paper on "Electric Crane Control"; and second prize, value £1 1s., presented by the Editor of *Electricity*, F. Anderson, Glasgow, for paper on "Testing of Electrical Machines."

ENGINEERING GOLFING SOCIETY.—The spring meeting of the Engineering Golfing Society was held at Littlestone, on Saturday and Sunday, 7th and 8th inst. On the Saturday morning, four-ball foursomes were played against bogey. The "Timmis" Challenge Cups and Mementoes were won by C. W. Myddleton and W. R. Manning with 4 up; the second prizes going to D. B. Mansergh and W. L. Mansergh with 2 up. In the afternoon there were two-ball foursomes against bogey, when the first prizes went to P. L. Riviere and H. P. Allison with 5 down; the second prizes falling to E. C. MacKellar and Walter Phillips with 7 down. These results were arrived at after a replay, necessitated by a triple tie including W. A. Brown and A. Williams. On the Sunday morning there was a medal round, and in the first division, "President's" Challenge Cup and Memento was won by A. W. Makovski with 85 – 8 = 77; the second prize being taken by C. H. Russell with 83 – 5 = 78, after with a tie with H. Greenwell. In the second division the "Wilson" Challenge Cup and Memento was won by H. G. Hale with 88 – 11 = 77; and the second prize by G. V. Twiss with 91 – 12 = 79. The scratch prizes in the first division fell to J. H. Skelton with 82; and in the second division to H. G. Hale with 88. In the afternoon friendly matches were played.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/–
(1) Spanish	18/6 to 21/–
(1) N. African	18/6 to 21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	22/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 5 0	
No. 1 Foundry	4 9 0	—
No. 3 Foundry	4 4 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 2 0	4 2 0
No. 1	4 2 6	4 2 6
Cleveland—		
No. 1	3 17 6	3 17 6
Silicious Iron	3 17 6	3 17 6
No. 3 G.M.B.	3 15 0	3 15 0
No. 4 Foundry	3 14 0	3 14 0
No. 4 Forge	3 13 6	3 13 6
Mottled	3 13 0	3 13 0
White	3 13 0	3 13 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 1 6	—
(3) Northampton—		
Foundry No. 3	3 17 6 to 3 19 0	
Foundry Forge	3 9 0	—
(3) Derbyshire—		
No. 3 Foundry	4 0 0	—
Forge	3 12 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 0 0	—
No. 4 Forge	—	—
Basic	3 17 6	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 15 6 (a); 4 18 6 (b); 5 2 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 5 0	11 0 0
Best	—	—
N.E. COAST—		
Iron Rivets	12 15 0	—
Common Bars	11 15 0	—
Best Bars	12 5 0	—
LANCS.—		
Crown Bars	11 0 0	—
Second Quality Bars	10 0 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	11 10 0	—
Best Bars	12 5 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	11 5 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 5 0	—
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	11 0 0
Ship Plates, ¼in. and up	8 2 6 to 8 5 0	£8 0 0 to 8 2 6
Sections	7 12 6 to 7 15 0	£7 10 0 to 7 12 6
Steel Sheets, under 3/16 in. to ¼in.	9 15 0 to 11 15 0	
Sheets (Gal. Cor. 24 B.G.)	—	£14 15 0 to 15 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 10 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0	
MANCHESTER—		
Bars (Round)	8 17 6	—
,, (Small Round)	8 5 0	—
Hoops (Baling)	11 9 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 7 6	—
,, (Lancs. Boiler)	11 7 6	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 5 0 to 7 10 0	
Hoops	12 0 0	—
Soft Wire Rods	9 5 0	—
MIDLANDS—		
Small Rolled Bars	8 10 0 to 8 15 0	
Billets and Sheet Bars	7 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	14 15 0 to 15 0 0	
Angles	7 15 0 to 7 17 6	
Joists	7 15 0 to 7 17 6	
Tees	8 15 0 to 8 17 6	
Bridge and Tank Plates	8 7 6	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/3 to 19/6
Block Tin (cash)	297 10 0
,, (three months)	288 2 6
Copper (cash)	55 11 3
,, (three months)	56 2 6
Spanish Lead (cash)	25 8 9
,, (three months)	26 1 3
Spelter (cash)	29 11 3
,, (three months)	29 15 0
MANCHESTER—	
Copper, Best Selected Ingots	61 5 0
,, Electrolytic	62 2 6
,, Strong Sheets	86 0 0
,, Tubes (Basis Price) lb.	0 1 0½
Brass Tubes (Basis Price) lb.	0 0 11½
,, Condenser lb.	0 1 1½
Lead, English	26 17 6
,, Foreign	26 0 0
Spelter	29 10 0
Aluminium (per ton)	£107

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 15 0	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£22 7 6	6/6
,, ,, Specially Refined		
,, ,,Max. 2 p.c. carbon	£36 5 0	11/6
,, ,, ,, 1 p.c. ,,	£42 5 0	15/–
,, ,, ,, 0.70 p.c. carbon	£54 0 0	17/6
,, ,, ,, carbon free	1/5d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£16 for home, £16 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 12 6	scale 5/– per unit
,, ,, 75 p.c.	£19 0 0	scale 6/– per unit
,, Vanadium	14/3 per lb.	
,, Molybdenum	5/– per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	9/3 per lb.	

FUELS.

SCOTLAND.

(Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/–
,, ,, Ell	14/6
,, ,, Splint	15/6 to 16/9
,, ,, Trebles	14/– to 14/3
,, ,, Doubles	13/– to 13/6
,, ,, Singles	13/– to 13/3
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/9
,, ,, Jewel	15/6
,, ,, Trebles	13/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/–
Screened Navigation	19/6 to 20/–
Trebles	14/6 to 15/3
Doubles	13/3 to 13/6
Singles	13/3
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/–
Secondary Steam	13/– to 13/3
Trebles	14/9
Doubles	13/3 to 13/6
Singles	13/– to 13/3

ENGLAND.

(8) N.W. COAST—	
Steams	27/6
Household	42/6 to 58/6
Coke	28/6 to 29/–
NORTHUMBERLAND—	
Best Steams	14/3 to 14/6
Second Steams	13/9 to 14/–
Steam Smalls	10/6
Unscreened	13/6 to 13/9
Household	21/– to 27/–
DURHAM—	
Best Gas	17/– to 17/6
Second	14/9 to 15/3
Household	21/– to 27/–
Foundry Coke	24/6 to 26/6

SHEFFIELD—	Inland.	
Best Hand-picked Branch	30/– to 31/–	
Best Selected House Coal	25/– to 27/6	—
Screened House Coal	22/– to 24/–	—
,, ,, Nuts	18/6 to 20/6	—
Yorkshire Hards	18/– to 20/–	—
Derbyshire Hards	18/– to 20/–	—
Rough Slacks	10/6 to 11/6	—
Nutty Slacks	8/– to 9/–	—
Smalls	3/– to 5/6	—
Blast-furnace Coke (Inland)	22/– to 27/6 at ovens.*	
,, ,, (Export)	f.o.b.	26/– to 27/–

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	22/9 to 23/6
Second ,, ,,	21/– to 22/–
Best Dry Large	21/– to 21/6
Ordinary Dry Large	19/6 to 20/–
Best Black Vein Large	21/– to 21/6
Western Valley Large	19/6 to 20/6
Best Eastern Valley Large	19/6 to 20/–
Ordinary ,, ,,	19/– to 20/–
Best Steam Smalls	14/3 to 15/–
Ordinary Smalls	12/– to 14/–
Washed Nuts	18/– to 22/–
No. 3 Rhondda Large	23/– to 24/–
,, ,, Smalls	16/6 to 17/–
No. 2 ,, Large	20/– to 21/–
,, ,, Through	18/– to 19/–
,, ,, Smalls	13/– to 14/–
Foundry Coke (export)	40/– to 45/–
Furnace Coke (export)	30/– to 32/6
Patent Fuel	25/6 to 26/6
Pitwood (ex ship)	31/6 to 32/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	41/– to 45/–
Seconds	32/6 to 37/6
Red Vein	27/– to 30/–
Machine-made Cobbles	45/– to 50/–
Nuts	45/– to 47/6
Beans	35/– to 38/–
Peas	20/– to 22/–
Breaker Duff	9/– to 9/6
Rubbly Culm	11/6 to 12/–
Steam Coals:	
Large	21/– to 22/–
Seconds	19/– to 21/–
Smalls	11/6 to 12/6
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. * Open market price. Special price for pig iron producers, 22/– per ton at ovens.

French Engineering Notes.

(From our Correspondent in Paris.)

Over-Production.

THE efforts to present the situation in the most favourable light have failed to conceal the fundamental weakness of the iron and steel trades, and there are many who declare that unless something is done to put the industry on a more satisfactory basis the existence of the Steel Cartel will be imperilled. The idea of the Cartel was to limit the production of steel to the needs of consumers. What has actually happened is that, while the quantity of steel going into consumption has diminished, the production has increased. In Germany the consumption is greater in proportion to the steel output than in other continental countries, and it was on account of the heavy home requirements that German steelmakers succeeded in raising the limit by a million tons during the second quarter of the year. Either that had to be done, or the deficiency in Germany would be made good by French, Belgian, and other steel producers belonging to the Cartel. During the first quarter of the year Germany, Belgium and Luxemburg had all exceeded their quotas, and they had consequently to pay to the common fund a considerable amount represented by the excess tonnage, some of which went to French steelmakers in the form of an indemnity for the tonnage below the quota, France being the only country to produce less than the proportion of the total output allotted to it. The result of this state of things has been to arouse strong feeling in Belgium, where it is alleged that French makers are profiting from this indemnity to offer steel for export at specially low prices. The Belgians are, therefore, particularly anxious to carry through the negotiations for the constitution of an international sales' organisation, first for girders and eventually for other steel products, but the meeting at Luxemburg does not appear to have brought the question much nearer solution than the previous meeting in Brussels, solely on account of the French and Belgian claims for much larger quotas than the other members of the Cartel will allow. The situation all round has, therefore, come to a deadlock. Outside Germany, the steel consumption is diminishing, and foreign orders are very scarce. There is nothing yet to indicate an improvement, and a general impression prevails that little can be hoped for during the present year. The fall in prices has failed to stimulate buying, and it is not likely that much would be done if prices declined still further, for consumption is restricted by the refusal of capital to embark upon any industrial undertaking, and also by the fiscal and other charges which weigh more heavily on industry than the cost of raw material. Six months ago merchant steel bars reached 1000 f. a ton. They are now 600 f., and it is doubtful whether they can be got down much lower, under present conditions at any rate, without an entire sacrifice of profits. It is true that every effort is being made to cheapen production, and a beginning has been made with a gradual cutting of wages. The lower coal prices have had only a slight effect upon the situation, and blast-furnace proprietors have been unable to secure any relief from German coke oven owners, who refuse to make any rebate upon the prices at which they supply coke. The situation is, therefore, difficult, and it becomes still more precarious in view of the increasing steel production of Great Britain, which is seriously complicating the foreign trade. In fact, the only hope for the future of continental producers appears to lie in Great Britain coming into the Steel Cartel.

The Cruiser Suffren.

Launched at Brest last week the 10,000-ton cruiser Suffren is the third of the same type that have been built under the existing programme of naval construction, the others being the Tourville and Duquesne. It differs from its predecessors in the sense that it is a little shorter, and some armoured protection is given to vital parts, notably the engine-room. This has been done at a sacrifice of speed, the Suffren being intended to steam at 33 knots, or a knot slower than the other cruisers. The impression is gaining ground that the total suppression of armour for the sake of an extra knot or so involves an undue risk. The Suffren has a length of 185 m. with a width at the water line of 20 m., and a draught of 6·3 m. There are three groups of geared turbines developing a total of 120,000 horse-power. The armament consists of eight 203 mm. guns in double axial turrets, two fore and two aft; eight 75 mm. guns, eight 37 mm. anti-aircraft guns and six torpedo tubes. The cruiser will carry two or three seaplanes, which will be launched by a catapult. The Suffren was put on the stocks just a year before she was launched, and her construction has, it is claimed, created a record in time and money.

Barrage Models.

At the Académie des Sciences, a method of making models to determine, with precision, the resistance of arched barrages, was presented on behalf of the inventor, Monsieur Veyried. The model is small, and is built up with a material of rather less resistance than concrete, and water is represented by a liquid of greater density, such as mercury. This particular method of model building is regarded as of so much value as a means of verifying calculations that experiments with it are being carried out at the Ministry of Public Works and the Government has placed at the disposal of the inventor a site for the erection of an experimental shop.

Works in Indo-China.

In view of the industrial depression it is hoped that arrangements will be made for putting in hand as early as possible a vast programme of public works in Indo-China, the carrying out of which will occupy at least twenty years, and, as the Colony is prosperous, it is believed that it will be able to defray the entire cost. Much has already been done during the past twenty-five years in the way of road, railway and harbour construction and of irrigation works for rice cultivation, and the new programme provides for the macadamising of several thousands of kilometres of road, the completion of the Hanoi-Saigon line, and the construction of railways between Tanap and Takkek and between Saigon and Battambang.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

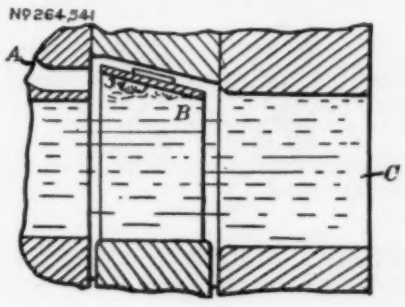
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

264,541. January 18th, 1927.—IMPROVEMENTS IN OR RELATING TO ELASTIC FLUID TURBINES, *International General Electric Company, Incorporated, of* 120, *Broadway, New York.*

Additional steam for overload purposes is admitted through nozzles A. The blades B of the following rotor wheel are extended in a radial direction at the point of inlet, whilst at the

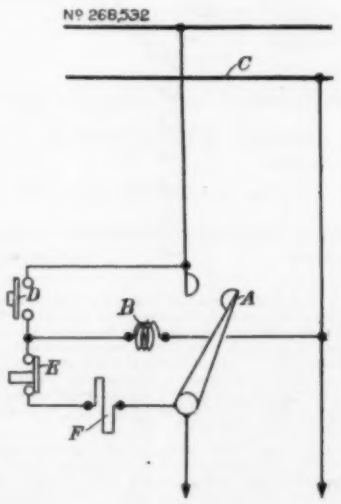


outlet end they are of normal form. The nozzles of the next stage C are of the usual kind employed in turbines, without provision for additional admission of steam. The eddy losses which are caused in the rotor wheel when working without additional driving medium are restricted to a short section of the inlet of the first wheel.—*April 7th*, 1927.

SWITCHGEAR.

268,532. March 9th, 1926.—IMPROVEMENTS IN OR RELATING TO THE CONTROL OF ELECTRIC CIRCUITS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, and William Royle and Leslie Newton Jones, both of the General Electric Company, Ltd., Witton Engineering Works, Witton, Birmingham.

The movable contact A of the switch is biassed in the open position and the switch is provided with a coil B, which may be connected across the bus-bars C. The contact A is open by means of a push button D. A circuit may also be made through the coil B by a push button E, and through an economy resistance F. Normally, the push button D is open, whilst E

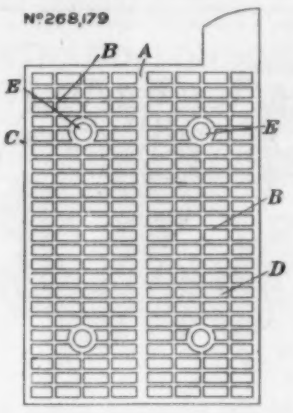


is closed. To connect the load to the bus-bars the push botton D is momentarily closed, and the coil B therefore closes the switch. As soon as the contact A has closed, the button D may be released, but the contact is retained closed by the current through coil B, push button E and economy resistance F. The switch contact A may be opened by pressing push button E, thereby interrupting the circuit of coil B. The arrangement obviates the necessity of using auxiliary switch contacts, whilst the use of the economy resistance makes it possible to use a large value of closing ampère turns without exceeding the desirable working temperature of the switch coil, and the switch may therefore be given a relatively long break, together with high contact pressure.—*April 7th*, 1927.

BATTERIES AND ACCUMULATORS.

268,179. May 28th, 1926.—IMPROVEMENTS IN AND RELATING TO THE MANUFACTURE OF ACCUMULATORS OR ELECTRICAL STORAGE BATTERIES, Sidney James Williams, of No. 9a, Stratford-road, Kensington.

The paste or active material is placed within a mould into which molten metal is poured, thus forming a grid on the outside of the active material, the active material and grids having openings formed in them to permit of expansion and contraction of the metal and lead oxide blocks. In the drawing A is the main channel communicating with the outside of the mould, B are cross channels and C surrounding channels. D is the lead oxide paste, which may be formed into hard blocks. E are openings formed in the grid to permit of expansion and contraction of the metal and lead oxide blocks or cakes. The plates may be formed in one operation and a battery may be built up by coupling together as many plates or cells as may be desired. The capacity of the battery is said to be considerably increased

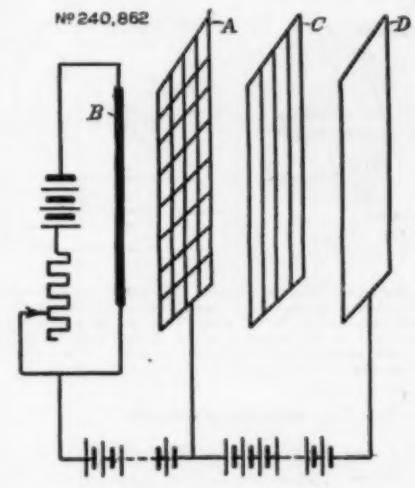


and by reason of the protection of the enclosed blocks of lead oxide by the grids, buckling is prevented and the durability of the accumulator increased.—*March 31st*, 1927.

TELEGRAPHS AND TELEPHONES.

240,862. October 3rd, 1925.—IMPROVEMENTS RELATING TO THERMIONIC DISCHARGE DEVICES, *The Edison Swan Electric Company, Ltd., of* 123–125, *Queen Victoria-street, London, E.C.* 4.

It has been found that the cathode of a thermionic valve can be maintained at the required temperature in a more economical manner than usual by bombardment by means of positive ions.

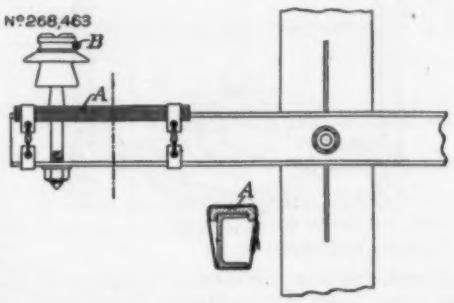


A wide mesh net A is placed opposite to the cathode B, and is given a suitable positive voltage, so that the positive ions of the gas flying towards the cathode excite it by their energy of bombardment and light to the desired activity. The grid C and anode D operate in the usual manner. The cathode which takes the form of a filament is first energised and heated by means of a battery, as shown, and then mained at incandescent temperature by the bombardment of ions.—*April 4th*, 1927.

TRANSMISSION OF POWER.

268,463. January 13th, 1926.—MEANS FOR PREVENTING SHORT CIRCUITS TO EARTH IN OVERHEAD ELECTRIC WIRES, British Insulated Cables, Ltd., of Prescot, Lancaster, and James Nelson, of 7, High-street, Prescot.

In order to prevent birds causing short circuits on overhead



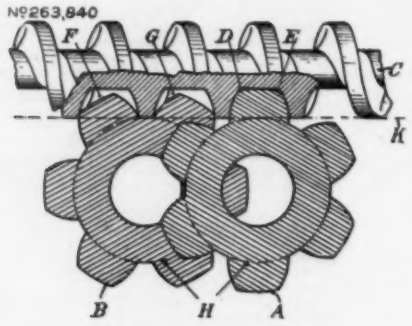
lines, an insulating perch is provided, as shown at A. If a bird alights on the supporting arm in a position adjacent to the conductor B, it will be insulated from earth, and hence no short circuit can take place through its body. The method of fixing the insulating perch is self-explanatory.—*April 7th*, 1927.

PUMPING AND BLOWING MACHINERY.

263,840. December 28th, 1926.—IMPROVEMENTS IN SCREW PUMPS, Motor-Pumpen-Aktiengesellschaft, of 1, Stampfenbachplatz, Zurich, Switzerland.

A screw pump constructed in accordance with this invention has two abutment toothed discs A and B displaced by 1½ pitches, and they co-operate with the screw piston C. The latter fits in a cylindrical bore of the casing and the discs are arranged in recesses of the casing, the suction and delivery branches of the

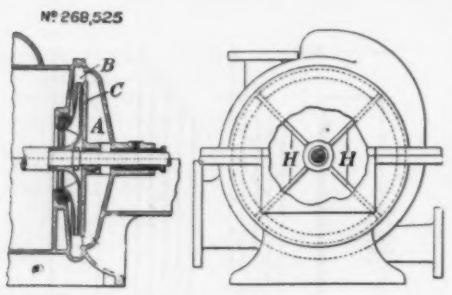
pump being in communication with cylindrical bore. In the position illustrated, the toothed disc A is in the deepest engagement, so that two small gaps D and E are formed, which do not completely close the working space in the screw piston; but they are so very small as compared with the spaces F and G, which are present at the same time at the other toothed disc B, that they may practically be neglected. It is of importance



that the closing of the working space should be effected by the aid of correctly constructed tooth flanks. These are shaped in accordance with the laws governing cycloidal or involute gear systems, the base circle H of the teeth of the disc coinciding with the pitch cycle of those teeth and rolling on the cylinder K, enclosing the screw piston so that a uniform movement of the toothed discs may be obtained with a comparatively small number of teeth.—*April 7th*, 1927.

268,525. March 2nd, 1926.—IMPROVEMENTS RELATING TO TURBINE AND LIKE PUMPS, Mather and Platt, Ltd., and Reginald Pennington, both of Park Works, Manchester.

According to this invention, the inner end of each stuffing-box is subjected to the delivery pressure of the impeller under all conditions of operation. At A there is an annular chamber to

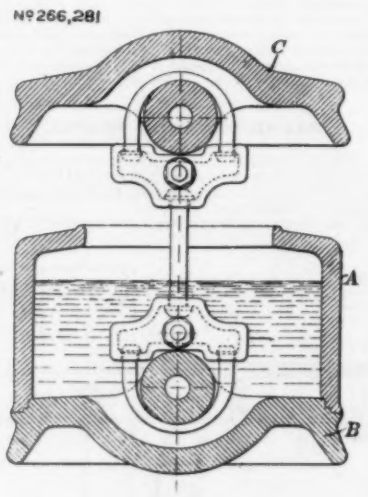


which the water from the pressure chamber B can gain access. The chamber is formed by a disc C, which has radial ribs or division pieces as at H, extending from its inner side to the adjacent end of the casing, of which it may form an integral part. The ribs prevent rotation or churning of the water.—*April 7th*, 1927.

MISCELLANEOUS.

266,281. July 12th, 1926.—IMPROVEMENTS IN INSULATORS, Société Nouvelle de la Manufacture de Porcelaines de Sainte-Foy l'Argentière, of 173, Boulevard Haussmann, Paris (Seine Department), France.

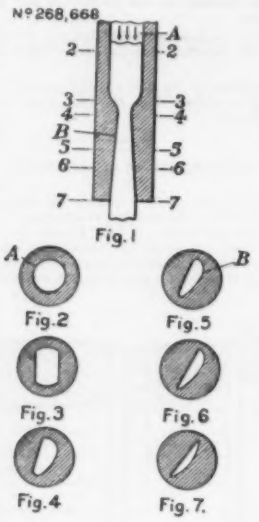
The bell A of the insulator described in this specification is



placed above the insulator B, and thus a cavity is formed which may contain oil, the quantity depending on the maximum inclination of the insulator. To prevent rain entering the oil container, the hood insulator C is placed above the container. —*April 7th*, 1927.

268,668. October 14th, 1926.—IMPROVEMENTS RELATING TO THE MANUFACTURE OF PROPELLERS, Ernest Mitchell, of Loretto, Rocky-lane, Monton Green, Eccles, Manchester.

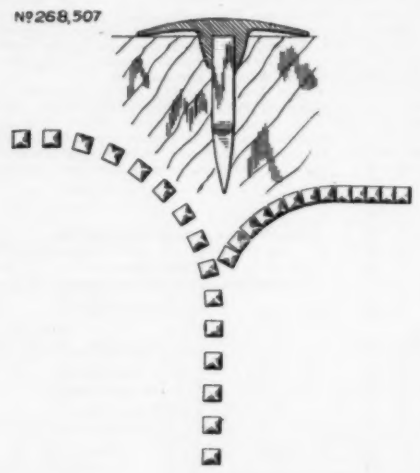
This invention relates more particularly to aeroplane and similar propellers made of light metals, and has for its object to provide a simple and efficient process which will give a fibrous structure to the metal of the propeller with the fibres running approximately parallel with the exterior surface of the propeller blades. The metal to be extruded, which may be in the form of a round ingot at a suitable temperature, is placed in the container A, Fig. 1, and has pressure applied to it by hydraulic means in the direction indicated by the arrows, whereby it is forced or extruded through the die B shaped to conform with the propeller blade to be produced. The interior conformation of the combined container and die varies in the manner indicated by the sectional plan views at Figs. 2 to 7, the views being taken on the corresponding lines 2 to 7 of Fig. 1. A part of the metal issues from the die into the open, the die, for example, enclosing one-half or one-third the length of the propeller blade. The container and die are in line with the blade being produced. The metal thus flows in a direction generally parallel with the



propeller exterior. The die may be shaped to conform to a complete blade. In the illustrated example, the container and die are combined. They may, however, be separate parts and adapted to be united in tandem or end to end. In either case, they are made in halves or segments to permit of lateral withdrawl from the extruded propeller.—*April 7th*, 1927.

268,507. February 12th, 1926.—IMPROVEMENTS IN MEANS FOR FORMING TRAFFIC CONTROL LINES UPON ROAD SURFACES, Walter Henry Baker, of No. 30, Newland-street, Kettering, Northampton.

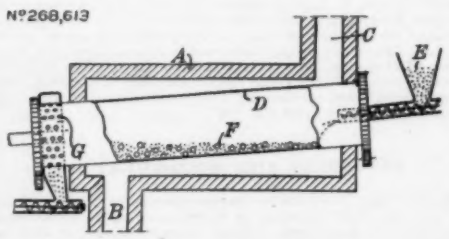
Marking lines for road traffic control purposes are made in accordance with this invention by driving spiral nails into the road surface. The shank of the nail may be of wrought iron or steel and of square section, with a tapering point, as shown.



The head is cast on the shank and a firm connection at the front is ensured by a boss on the underside of the head. The head of the nail is thinned at the margin by bevelling it or rounding it, as shown. To comply with official regulations which usually specify that traffic lines should have a width of 4in., the dimensions of the head are 4in. square. In fixing the nails in the road, they may be arranged in contact with one another, as shown in the right-hand lower illustration, or they may be spaced apart, as shown on the left.—*April 7th*, 1927.

268,613. July 15th, 1926.—APPARATUS FOR THE CARBONISATION OF COMBUSTIBLES AT LOW TEMPERATURES, Charles Pamart, of Bruay (Pas-de-Calais Department), France.

The arrangement described in this specification is for the carbonisation of combustibles at low temperatures and for the manufacture of pure pulverised half coke. Within a casing A, connected at B with a furnace or gas burner and at C with a chimney, there is an inclined drum D, which is rotated by means of gear wheels. The combustible material to be



treated is fed into the hopper E, and it drops on to a screw conveyor which feeds the drum. The drum contains metal balls F. When the balls have been raised to a temperature of 500–600 deg. Cent., the combustible material which is fed into the drum is at once in a favourable condition for carbonisation. The balls also prevent the material caking. Moreover, when the material has been brought to the state of half coke, the balls act as crushing elements. The material drops from the lower part of the drum through the holes G.—*April 7th*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—92, Victoria-street, Westminster, S.W. 1. Metropolitan District meeting. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Final meeting of the winter session. "Stability of Dredged Cuts in Alluvium," by Herbert Chatley, D.Sc. (Eng.). 7.30 p.m.

THE PHYSICAL SOCIETY.—Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. "The Theory of Luminescence in Radio-active Luminous Compounds," by Mr. J. W. T. Walsh, M.A.; "Distortion of Resonance Curves of Electrically-driven Tuning Forks," by Mr. E. Mallett, D.Sc.; a demonstration of an electro-magnetic relay, with separate make and break joints, for temperature regulations, will be given by Mr. J. Guild, 5 p.m. Editing Committee meeting at 3.45 p.m. Council meeting at 4 p.m.

ROYAL INSTITUTION.—21, Albemarle-street, London, W. 1. Discourse, "Concerning Old Age," by Sir Rumphry Rolleston. 9 p.m.

SATURDAY, MAY 14TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Cleckheaton. Yorkshire District meeting. 2 p.m.

MONDAY, MAY 16TH.

RAILWAY CLUB.—25, Tothill-street, London, S.W. 1. Paper, "Some Railway Byways," by Mr. C. N. Anderson. 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—The Royal Society of Arts, 18, John-street, Adelphi, London, W.C. 2. 15th Wilbur Wright Memorial Lecture, by Dr. L. Prandtl. 6.30 p.m.

WEDNESDAY, MAY 18TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Wireless Section meeting, Savoy-place, Victoria Embankment, W.C. 2. "Wireless Works Laboratory," by P. K. Turner. 6 p.m.

INSTITUTION OF SANITARY ENGINEERS.—Visit to the works of A. and F. Pears, Ltd., at Isleworth. 2.30 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, S.W. 7. "Cyclones and the General Circulation," by Mr. Harold Jeffreys, D.Sc., F.R.S.; "Early Water-mills in Relation to Changes in the Rainfall of East Kent," by Mr. George M. Meyer, B.A., Assoc. M. Inst. C.E.; "Report on Winter Thunderstorms in the British Isles from January 1st to March 31st, 1926," by Mr. S. Morris Bower, F.R. Met. Soc. 5 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Industrial Welfare in Great Britain and the United States," by Robert R. Hyde. 8 p.m.

SOCIETY OF GLASS TECHNOLOGY.—Hotel Cecil, Strand, W.C. 2. Ninth annual dinner. 7 p.m. for 7.15 p.m.

WEDNESDAY, MAY 18TH, AND THURSDAY, MAY 19TH.

SOCIETY OF GLASS TECHNOLOGY.—Special general meeting, University College, Gower-street, London, W.C. 1, on Wednesday, at 2.30 p.m., which will be followed at 2.40 p.m. by an ordinary general meeting to receive and discuss the following papers:—"The Decomposition of Glass by Water at High Temperatures and Pressures," by Dr. G. W. Morey and Dr. N. L. Bowen; "The Brittleness of Glass," by Professor G. Gehlhoff, Dr. Phil.; "The New British 15-arm Automatic Suction Bottle Machine," by Mr. F. Redfern; "Standard Durability Tests for Bottles." On the Thursday afternoon at University College, Gower-street, London, W.C. 1., general discussion on furnace efficiency. The discussion will be continued on the paper presented by Professor W. E. S. Turner to the April meeting, on "A Brief Review of Furnace Developments. 2.30 p.m. Visit to the Lamp Works of the General Electric Company, Ltd., Brook Green, Hammersmith, London, W. 6., on Thursday, 10.15 a.m.

FRIDAY, MAY 20TH.

ROYAL INSTITUTION.—21, Albemarle-street, W. 1. Discourse, "Structure of the Silicates," by Professor W. L. Bragg. 9 p.m.

FRIDAY AND SATURDAY, MAY 27TH AND 28TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Wales district meeting at Newport.

SATURDAY, MAY 21ST.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit of the Junior Section to the works at Ashton-under-Lyne of the National Gas Engine Company, Ltd. Parties will commence to tour the works at 2.45 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District Meeting at Berwick-on-Tweed, to inspect the New Bridge. 2.30 p.m.

TUESDAY, MAY 24TH.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the Showrooms of Holophane, Ltd., Westminster, and lecture and demonstrations, "Stage and Colour Lighting," at 7 o'clock.

THURSDAY, MAY 26TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Ilkeston. East Midland District meeting. 10.45 a.m.

SATURDAY, MAY 28TH.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the Shell Haven Installation of Shell-Mex, Ltd. 1 p.m.

THURSDAY, FRIDAY AND SATURDAY, JUNE 2ND TO 4TH.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Scottish District meeting at Dunfermline.

TUESDAY, JUNE 28TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Visit to the Kent Cement Works at Greenhithe by steamer, which will start from Westminster Bridge Pier at 10 a.m.

THE TOTAL ECLIPSE OF THE SUN.—A lantern lecture on the Total Eclipse of the Sun, which will take place on June 29th and which will be the first total eclipse visible in England for 200 years, will be given by the President of the Royal Astronomical Society—Rev. T. E. R. Phillips—on Friday, May 27th, at 8 p.m., at the Polytechnic (Fyvie Hall), Regent-street. The receipts from the lecture will be devoted to King Edward's Hospital Fund for London.